JOURNAL

OF THE

FRANKLIN INSTITUTE

OF THE STATE OF PENNSYLVANIA,

FOR THE

PROMOTION OF THE MECHANIC ARTS.

VOL. LVIII.] NOVEMBER, 1869. [No. 5

EDITORIAL.

ITEMS AND NOVELTIES.

Pile Drivers.—After witnessing the beautiful and efficient operations of the gunpowder pile-driver, I have been led to inquire into the principles of its efficiency. Why will a hammer, falling through a certain height and forced upward by gunpowder, be more efficient than a hammer which is forced upward by other means? In the gunpowder hammer, the first important thing to be observed is—*the hammer does not strike* the pile. The plunger in front of the hammer compresses the air in the cavity in the cap, and, if the plunger fitted air-tight, it would form an air spring between it and the plunger, and as soon as the forward motion was arrested, it would, by reaction, force the hammer upward. But in this case, the compression of the air, by evolving heat, explodes a charge of gunpowder, and the expanding gases produces an

intensified gaseous spring. In this way the iron in the hammer is prevented from coming in contact with the iron of the cap, and the pile is forced forward by an *intense, powerful push*, and not by impact, as in ordinary cases. It may, however, be considered a case of elastic impact, and analytical investigations show, that in elastic impact there is no work lost. In the ordinary pile-driver only a portion of the work of the fall is expended in driving the pile, the lost work being expended in bruising and destroying the head of the pile and the hammer.

These principles suggest an improvement in the drop-hammer and in the direct-action pile-driver, which is illustrated in the annexed figure. Let the lower end of the hammer be provided with a plunger passing nearly air-tight into a cavity in a cap over the pile, the same as in the gunpowder pile-driver. But, as it will not pass in air-tight, some of the air will escape from the cavity, under which condition the plunger could not be drawn out without producing suction, and hence a lifting force on the pile. To prevent this, make a small air passage near the bottom of the cavity, which shall communicate with the external air, and in this passage place a puppet or other valve, which shall let air freely into the cavity, but which shall automatically close when the air attempts to escape. The passage might enter the bottom of the cavity, and a flap of leather or rubber be placed over it.

Another principle in its economical working, consists in forcing the pile down by the same force which drives the hammer upward. In ordinary machines, the steam or other power which drives the hammer upward does not, at the same time, drive the pile downward. From this it appears, that if all the external machinery, in both cases, be left out of the question, it would be as economical to expend twice as much for powder power as for steam power. This statement, however, would not be true for a direct-action pile-driver, in which the engine rests upon the top of the pile, for in this case the engine would press downward while the hammer is being raised.

The external machinery for operating the hammer has little to do with its efficiency, so long as it is in order, but the almost entire absence of machinery in the powder driver, and especially of any machinery which will get out of order, is a novel and commendable

feature. But as the machinery for operating ordinary pile-drivers run a long time without repairs, the main question with the practical man will be the economy of the driving power. D. V. W.

University of Michigan, Oct. 12, 1869.

The Ejector-Condenser.—In the latter part of this number will be found the paper on this subject, read at the last meeting of the Institute, by Mr. J. R. Napier, and some remarks by various members.

The action of this instrument is so curious that in addition to the practical details of its structure and operation a few words respecting its "rationale" may not be out of place. The principles applied to the explanation of the *injector* by the present writer in an article on p. 54, Vol. LVI., of this Journal, and developed in a more general form in a brief discussion, on "Resistance and Transmission of Motion," in Vol. LVI., page 344, will apply fully to this case.

Referring to Mr. Napier's paper, with its accompanying plates, for a description of the apparatus and its working, we will only here remark that with it the exhaust steam from the cylinder after expansion, and with an absolute pressure of but 2½ to 3 lbs. per square inch or 12½ to 12 lbs. *below the pressure of the atmosphere*, flowing into a series of nozzles where it meets a stream of water and is condensed, is able not only to eject itself against the atmospheric pressure and to carry the condensing water with it, but even to lift this latter from a depth of several feet, or force the entire stream to a corresponding height.

How is this seeming paradox to be explained? We think, as follows:—

The steam, whose pressure is reduced to but 3 lbs. per square inch above an absolute vacuum, is for the same cause expanded to about five times its normal bulk or that which it would have at atmospheric pressure, or, comparing it with water, would have a bulk about 7050 times as great as the water from which it was formed and consequently would be contracted to $\frac{1}{7050}$ of its bulk if condensed into water.

Now, in fact, as it flows out of the nozzle, this very condensation happens to it, and supposing the jet to maintain simply the initial velocity due to the feeble 3 lbs. pressure, it would form a cone of which the steam-supplied base would be 7050 times larger than the condensed-water apex.

But the pressure of 3 lbs. per square inch is acting on the large base, and by reason of the motion given to the particles, is transmitted to the small apex; so that, considering this point alone, we see that the pressure of 3 lbs. per square inch at the first point might become 7050×3 or 21,150 pounds per square inch at the latter.

It will be of course evident to any one that the contraction of the jet is here the result of its condensation simply and thus has no effect upon its forward motion any more than the running together of the passengers on a steamer would have on her velocity, and is in no wise related to such contractions as are produced by a nozzle, or conical tube in which the forward motion is resisted by the very inclined surfaces which affect its concentration. The only office of a surrounding tube is to guide the stream and to prevent indraught of air which would otherwise be set in motion to the detriment of the legitimate work of the steam and water jets.

We may, indeed, compare the effect of the scattered particles in the dilated steam as they condense in the jet, to the result of a concentrated fire on a point of fortification, and should it be suggested that the same effect might result without condensation we can answer that it is *only* by *this* means that so many particles can be made to act at once within so small an area, and without waste of their moving force in effecting the concentration.

But we have made no account of the water required for condensation, this also must be set in motion by the escaping jet.

Suppose 20 lbs. of water are required to condense each pound of steam, and that this water, having no head, must receive all its motion from the steam, then, clearly, the velocity of the jet will be reduced to $\frac{1}{21}$st. of what it was before, when thus applied to moving a total weight 21 times as great; but to carry the same quantity at a velocity reduced 21 times, the area of the stream must be increased 21 times: thus the small end of our *cone of condensation* would be enlarged 21 times for this cause, and the base and apex, in place of being as 7050 to 1 would be as 7051 to 21.

Not only, however, have we rendered the apex of our cone larger by reducing the velocity as above, but we have also increased its size, in an equal degree, by adding the additional volume of water, which, with the condensed steam, makes a volume 21 times as great as the latter: in other words, not only does each pound of water take 21 times as much room to pass at $\frac{1}{21}$ of the velocity, but there

are 21 times as many pounds of water to pass. We must then enlarge the small end of our cone 21 times again for this reason; it thus becomes 21×21 or 441 times as large as on the first supposition of the steam condensing without the addition of water, and the relation of the large end to the small one becomes 7050 to 441.

Now, on the steam end, as we have seen, is a pressure of 3 lbs. to the square inch, while on the water end of the cone of condensation is the atmospheric pressure of 15 lbs. But $7050 \times 3 = 21{,}150$, while 441×15 only equals 6,615, or less than one-third the former, therefore the condensed steam and water would be ejected with great force under the conditions assumed.

But let us see how far these conditions can be realized in practice, and first, to save repetition, let us remark, that the effect of the steam pressure is diminished in proportion to the square of the added weight of water. This is evident by inspection of the discussion just given.

By reference to the table in Prof. Rankine's report of October 27, 1868,* it will be seen that the average amount of heat taken up by the water was about 40°.

Let us assume the latent heat of the steam to be 972°, the feed water to be at 40°, and the discharge at 80°, as it was, in some cases, the "*round numbers*" being most convenient; then to condense the steam would imply an absorption of 972° and to cool it from 150° (about its presumable temperature at 3 lbs. absolute pressure) to 80°, would require a further absorption of 70°, or in all 1043°, which must be taken from each pound of steam to reduce it to water at 80°. As each pound of water in passing from 40° to 80° absorbs 40° of heat, each pound of steam will need $1043 \div 40 = 26$ lbs. of water for its condensation and cooling. The outlet of the ejector must then be enlarged 26 times by reason of this increased amount of water which is to be passed through it, and if there is no head to give this water the requisite velocity, the escaping steam must give up a corresponding amount of its motion to this water and so reduce its velocity 26 times to move this superior weight, as a result of which the outlet must be enlarged 26 times again to admit the escape of the liquid at this reduced rate, its area therefore becomes 676 times as great as it would have been could the steam have been condensed without addition of water. This, of course, greatly changes the relation of the steam and water ends of our imaginary cone, which in place of being as 7050 to 1 are as 7050 to

* This report has been crowded out of this number, but will appear in our next.

676, or about as 10·4 to 1, yet even then we have the pressure or force of 3 lbs. per square inch on 10·4 of area exerting a force of 31·2 decidedly superior to the atmospheric pressure of 15 lbs. per square inch on the area 1 of the outlet.

It must be here remembered that we have assumed the absolute pressure of steam or vacuum to be 3 lbs. throughout, while the diagram, and our judgment show us that it is far greater at the beginning of each exhaust, in consequence of which the steam will arrive at the base of the *cone of condensation* with a velocity due to this excess of pressure, and so exert an additional force which has not entered into our calculation as given above.

In thus treating this question as a statical rather than a dynamical problem, we depart from the usual method, but, in the first place, gain unquestionably much in brevity, and more in clearness of explanation to those not habitually familiar with mathematical work, while we sacrifice nothing in accuracy.

The best proof of this, to those who have not time to go into the merits of the question, is found, we think, in the fact that numerical results deduced by this process, agree precisely with those obtained by the highest authorities in the usual and less evident method. This, in the classical explanation of the Injector, by Prof. Ch. Combes, Inspector-General and Director of the *Ecole des Mines*, translated in this *Journal*, Vol. XXXIV., p. 325, the maximum quantity of water which a Giffard Injector could introduce with a constant pressure of 75 lbs, is shown to be 18·7 times the weight of the steam in *addition*, or *with* the condensed steam 19·7 times.

Now, at 75 lbs. pressure, the volume of saturated steam is 388 times that of the water into which it would condense. Therefore, the areas of the base and apex of its cone of condensation would be as 388 to 1, and the concentrated pressure on the smaller area would, therefore, be 388 times that of the boiler. The added water, however, as we have seen, diminishes this concentration in proportion to its square by enlarging the smaller end, first by its volume, and then by its reduction of the velocity: therefore, the square root of 388 or 19·7* will express the amount of water, which would reduce the proportion to an equality—*i. e.*, make the pressure per square inch of the injected water like that of the escaping steam, equal to the boiler pressure, thus implying that the steam was just able to enter the boiler against *its* pressure, without any allowance for friction. But this is exactly Prof. Combe's result.

* This root is strictly 19·692, &c.

Steam Omnibuses.—At a recent meeting of the Glasgow police court, Messrs. Honeyman and Drummond obtained the sanction of the authorities to run steam omnibuses, by way of experiment, on the streets of Glasgow.

Submarine Pumping.—A number of submarine sweet-water springs are known to exist along the coast of Istria and Dalmatia. As the coastal districts of these provinces suffer from want of a sufficient supply of water, and it is possible by means of the Norton pump to save much that is now lost, the Austrian Ministry of Agriculture has published a book on the means of finding and utilizing submarine fresh-water springs on the Austrian coasts.

Rust of Iron Ships.—Prof. Calvert has given some interesting results of his experiments into the nature and condition of rust. Oxidation of the bottom of iron ships, he thinks, may be prevented by an external coating of a preparation of an alloy of lead and antimony, while an alkali is placed in the bilge water within the vessel.—*Mech. Mag.*

The Suez Canal.—The Suez Canal Company has just issued regulations for the navigation of the Suez Canal, to be opened on November 17th. Article 1 states that the navigation of the Suez Maritime Canal will be open to all ships without distinction of nationality, provided their draught of water does not exceed 7½ metres, the depth of the canal being 8 metres, equal to 26 English feet.—*Mech. Mag.*

Removal of Gas Works in London.—The great city gas companies are preparing to remove their works from the midst of the crowded localities in which they are now placed, and carry them into the country. The existence of these works in their present position has long been a grave nuisance. The Imperial Company has secured a location in the fields near West Ham; the Chartered on the river bank, near the northern outfall of the great main-drainage system; and the City Company, at Blackfriars, will, it is believed, migrate in the same direction. It is to be trusted that all the metropolitan gas companies will presently find it to their interest to remove entirely without the boundaries of the thickly-inhabited districts.—*Lancet.*

Damp Walls.—Our attention has of late been called to the question of rendering the walls of buildings impervious to moisture. We have received letters upon the subject from correspondents who ask us to point out a remedy for the evil. We therefore gladly

take the opportunity of making known to our readers that there is a remedy, at once simple and efficacious. This is a process invented by Mr. Frederick Ransome, and which is being successfully carried out in practice by the Patent Stone Company, East Greenwich. It consists in the employment of colorless mineral solutions which possess the property of forming an insoluble and indestructible mineral precipitate when applied to buildings. The deposit takes place not only on the surface of the material to which it is applied, but enters the body of the substance. The application of the solution in no way alters the color of the material, a perfectly natural appearance being preserved in the building. The effect is permanent, neither atmospheric nor saline influences in the least degree affecting the indurating material. It not only renders the building water-proof, but it further most effectually indurates and preserves from decay the stone or bricks treated with it. This process has recently been applied to several buildings which are stated to have been untenantable, previously to the application, on account of exposure to a wind-driven rain. Paper now hangs well on the walls from which it formerly drooped in festoons and tatters, whilst dryness and a cleanly appearance have taken the place of dampness and mildew. This process of rendering buildings impervious to wet is comparatively inexpensive, therefore no one need longer to suffer from that source of discomfort and danger to health, damp walls.—*Mech. Mag.*

Gas-tight Rubber Tubes.—India-rubber tubing is slightly permeable to gas. As a fact, the amount which escapes through the walls of the tube is very small, but there are places in which it may be advisable to render any escape impossible. This can be done by giving the tubing a thin coating of a varnish made by dissolving one part and a-half treacle and two parts of gum-arabic in seven parts of white wine and three and a-half parts of strong alcohol. That is the receipt of M. Jouanne, but we have no doubt that beer may be substituted for white wine without harm. The treacle and gum must first be dissolved in the beer or wine, and the alcohol must be added very slowly, constantly stirring the mixture, or the gum will be thrown down.—*Mech. Mag.*

Old Shoes Converted into Combs.—Old shoes are not altogether wasted, but they have been put to a new use by M. Guyot. He cuts them up into thin shreds, and treats these with chloride of sulphur. Under this treatment, the shreds at first swell up and

then become friable and brittle. When this stage is arrived at, they are washed, dried, and ground to a fine powder, which we are told is of a grey rose color. This is mixed with some gummy or glutinous matter, and the mass is pressed into moulds to form combs, buttons, knife-handles, and such like articles. During the treatment with chloride of sulphur, it must be mentioned that the vapor of hydro-chloric acid is given off, which, on hygienic grounds, requires to be condensed. Then, when the shreds arrive at the brittle state, it is necessary to remove the excess of chloride of sulphur, and, we imagine, sulphur also. This is done by washing with sulphide of carbon, the recovery of which demands precaution. Taking all things into consideration, we doubt whether M. Guyot can make much profit by his process for converting old shoes into combs, although, by putting on the head what was once on the feet, he may, in one sense, be said to make both ends meet.—*Mech. Mag.*

Water-proof Fabrics.—M. Neuman has discovered a new way of water-proofing, or, rather, of making fabrics impermeable to water. The operation is simple, but it must be carried on with care, or the fabric will be ruined. It consists in submitting the tissue it is wished to make impermeable to the action of moderately strong sulphuric acid (57° Baume) for a space of time varying from a second or two to two minutes, according to the nature of the fabric. By the action of the acid the fibres, whether of wool or cotton, are superficially decomposed into a glutinous material. As soon as this has happened (the time required must be found by experiment) the fabric is passed rapidly through water, and well rinsed and finally dried, first in the air and then over cylinders. The glutinous matter will, of course, fill up all spaces between the threads, and no doubt the fabric will be made impermeable. Another way of effecting the same object is to completely dissolve cotton or linen in sulphuric acid, and spread the solution over the fabric either by means of cylinders or a brush. Calendering seems to be advisable in both cases.—*Mech. Mag.*

Naphtha as Fuel.—The attempts to employ naphtha as fuel have at length proved successful. On July 31st a train arrived safely in Kutschujan, 81 versts from Charkoff, whose engine was heated with raw naphtha instead of coals. The honor of the invention is ascribed to the mining engineer Portski.—*Mech. Mag.*

Mr. James Young, so well known in connection with the paraffine industry, has presented 10,000 guineas to Anderson's Uni-

versity, Glasgow, for the purpose of founding a chair of technical chemistry, and establishing bursaries, scholarships, &c. Mr. W. H. Perkin, F.R.S., who, it will be remembered, delivered a course of Cantor lectures before the members of the Society of Arts during the last session, has been appointed the first professor.—*Chem. News.*

Oxygen Manufactured on the Large Scale.—The works for this purpose, at the foot of Forty-first Street, New York, are at last in successful operation. They occupy a lot 2,000 feet square, and consist of retort-houses, engine-rooms, store-house and office, air-pumps for compressing gas in cylinders, and a gas-holder of 26,000 cubic feet capacity.

In the accounts heretofore published by the inventors of this process in the French journals, and copied in the English and American ones, an incorrect account has been given of its operation. The following is, however, the accurate description, as we learn from the *American Artizan*:—

"The essential or characteristic portions of the process are carried on by the aid of brick furnaces, of which only one was in operation at the time of our visit, several others being, however, rapidly put up and fitted for use. Each furnace has its fire-box so arranged as not only to heat the retort which holds the manganate of soda (the vehicle through which the process is carried on), but also one or more chambers through which an air-blast passes to the retort. The retort, furthermore, communicates, by a pipe furnished with stop-cocks, with a suitable steam boiler. The process is carried on as follows:—About 600 pounds of manganate of soda are placed in the retort, heated to the requisite degree in the furnace; superheated steam from the boiler is then admitted for about ten minutes. Two equivalents of the manganate of soda and two of water react upon each other, as indicated by the formula:

$$2\,(Mn\,O_3, Na\,O) + 2\,(HO) = 2\,(Na\,O, HO) + Mn_2, O_3 + O_3.$$

In other words, the water combines with the soda of the manganate to form a hydrate of soda. The manganic acid is changed to sesquioxide of manganese, containing only half the proportion of oxygen, and the other half of the latter passes off in a free condition. At the conclusion of this part of the process, the steam is shut off, and the superheated air is admitted for about fifteen minutes, whereupon the sesquioxide combines with more oxygen from the air, and is converted back into its original form of manganic acid, which, of course, resumes its former relation to the soda,

reconstituting manganate of soda, ready for a repetition of the process. In forcing the air to the apparatus, a steam pumping-engine is used, noticeable for the manner in which friction gearing is applied to transmit power from the engine to the air-forcing pumps, without the jar incident to the use of cogged wheels. The air-blast passes first through cylindrical vessels containing caustic soda, by which its carbonic acid is removed, and thence through the superheating chamber previously mentioned, to the retort. The retort is never opened, as the material shows no signs of deterioration by by use. That in the retort at the time of our visit was tested continuously for six months before being brought to this country, and has been in constant use for six weeks past, the period during which the works have been in constant operation. As the oxygen leaves the retort it passes through a suitable meter, which registers the quantity, and thence to the gasometer, which, at the present time, contains 25,000 feet of oxygen gas, much purer than is required for most of the purposes for which it is to be employed."

The retorts in each furnace are charged with 700 pounds of permanganate of soda, and by the consumption of 2 chaldrons of coke, and with the labor of 3 men, 25,000 cubic feet of oxygen is made per day; and as only a portion of this amount can, as yet, be disposed of, a vast quantity is blown off into the air. It is stated, that at a price of 2 cents per cubic foot, a good margin would be left for profit, were the demand sufficient to utilize the capacity of the works; but the present selling price is 5 cents per cubic foot, compressed in reservoirs up to a presure of 250 pounds per square inch.

We employed a quantity of this gas for some experiments lately, and found it of excellent quality. It is already, we hear, in use to light up shop-windows in several places in New York, and we hope soon to record its application on one of our great coal-carrying railroads, on a very extensive scale. The experiments in that direction having been very satisfactory.

Photographs of Nobert's Bands.—In *Silliman's Journal* we have a paper by Dr. Woodward, who has so distinguished himself by his micro-photographic results, describing his success in photographing a new plate by Nobert, containing 19 bands with a $\frac{1}{16}$ objective, by Powel & Leland. No lens, previously, had been able to resolve the lines in these bands beyond the 15th.

Photographing Without a Lens, or the method adopted by

Mr. James Thomson, of Glasgow, to photograph the bodily organs of fossil corals. Each of these fossil corals is nearly as large as a hen's egg, and Mr. Thomson, it will be remembered, cut a thin slice out of the centre of each coral, and then ground down and polished the stone slice till it became thin and translucent enough to be used as a negative from which to take photographic prints on paper. When he exhibited these valuable photographs at the British Association at Norwich, last year, Mr. W. H. Harrison recommended him to have them copied in future by the permanent carbon process. Mr. Thomson, in consequence, went to Newcastle-on-Tyne, saw Mr. Joseph W. Swan, the patentee of the chief Carbon process, and made arrangements for a large supply of permanent photographs from the stone negatives. Some of these carbon prints were exhibited at Exeter, and met with much approval. Mr. Thomson says that he and Mr. Swan are now trying experiments upon a new process, which they hope will result in the production of blocks from the coral sections which can be used in the common printing press, to print from in printing ink.—*Mech. Mag.*

Rocksalt Prisms.—Mr. C. Brooks, F.R.S., narrated to Section A, how he and Mr. Browning, the optician, had tried to make rocksalt prisms for use in a heat spectroscope. Supposing the base of the prism to be parallel to the line of cleavage of the crystal, it was found that in nearly every instance the apex of prism split off, and that, as a rule, long before the apex had been ground down to anything like a sharp edge. They therefore thought they would try the influence of annealing upon the crystal, so put one of them in a tin box full enough of sand to well cover the piece of rocksalt, and with a slow and gradual increase of heat, brought it in the course of a few hours to a very high temperature. It was then allowed to cool very slowly indeed. The result of this treatment was to produce pieces of rocksalt which could be ground into prisms without much danger of the splitting of the crystal.—*Mech. Mag.*

Selective Reflection.—During the visit of the British Association to Exeter, several novelties of interest relating to light and optics were brought under the notice of the members. One of the principal of the discoveries was made known by Prof. Gustav Magnus, who found out, by experiment, that fluorspar reflects the waves of ether thrown off by hot rocksalt more than any other polished surface out of the very large list of substances which he tried. Hence, if these long waves were visible to the eye, fluor-

spar would sparkle more brilliantly in such rays than would the polished surfaces of metals. Dr. Balfour Stewart, who was on the platform of Section A during the reading of the paper, called attention to some experiments of his own made a few years ago, tending to prove that the heat rays emitted by rocksalt are very long ones, belonging almost to the extremity of the spectrum. He also found out that, despite the general transparency of rocksalt to obscure heat, it shows great opacity to the heat rays emitted by a second piece of its own substance.—*Mech. Mag.*

In Repeating Tyndall's Experiments on the action of light on vapors, M. Morren found out that even the purest sulphuric acid, quite free from arsenic and other foreign substances, liberates traces of sulphurous acid gas, and thereby causes the formation of a cloud. This fact shows that, in some cases, this method of experimenting is a very delicate test for the presence of certain chemical substances. Moreover, the discovery made by M. Morren affects a large number of the experiments on the action of gases upon radiant heat made by Prof. Tyndall, and published by him in his celebrated work, *Heat Considered as a Mode of Motion*. In all those experiments Dr. Tyndall dried his gases by means of powdered glass and sulphuric acid, so that, as shown by M. Morren, traces of sulphurous acid gas must always have been present in his experimental tube, and influencing the result to a certain extent.—*Mech. Mag.*

Electrolytic Iron.—Dr. Jacobi read a paper before the British Association on the electro-deposit of iron. The learned Professor illustrated his remarks by a series of plates of extreme beauty. The solution from which the metallic iron was deposited consisted of a double salt, the sulphate of iron, and magnesia. It was found desirable to coat the recipient of the deposit with a thin film of nickel or copper. Specimens illustrating the application of the electro-deposit of iron to purposes of engraving (aided by photography) were also exhibited.—*Mech. Mag.*

Meteors.—Prof. Newton, a distinguished American astronomer, in the course of a speech made at the British Association, said that observations of meteors made in the United States tended to prove that the November meteors burnt up at a much higher altitude in the air than the August meteors. He therefore raised the question whether the resisting medium in space which transmits waves of light may not have retarded the lighter fragments forming the

meteoric showers more than it retarded the heavy substances. If so, it might be possible that the lighter fragments were formed of different chemical substances to the heavier ones, and so burnt up at a higher altitude in consequence. He broached this question, he said, merely as a passing idea, and not as possessing any great weight. Perhaps the spectroscope may hereafter give some information upon the point.—*Mech. Mag.*

Duration of Electric Discharges.—In the last number of *Silliman's Journal*, we notice an admirable paper by Prof. O. N. Rood on the above subject. His apparatus, in general arrangement, resembled that used by Wheatstone in his remarkable experiments for determining the velocity of electric conduction, which were, no doubt, the basis of all similar processes for the measurement of extremely small intervals of time, which have been since devised.

The improvements introduced by Prof. Rood consist chiefly in throwing the image of the spark elongated by the rotating mirror by means of a lens on a plate of ground or polished glass, and viewing it with a magnifying lens.

There were, beside, various ingenious devices in the details of structure and arrangement such as have distinguished other investigations of this eminent physicist. As a result of various experiments, Prof. Rood finds, in the first place, that the discharge from a Leyden jar charged by an induction coil, is composed of three parts or successive acts—a white flash, a brownish-yellow gleam, and a fainter and more lasting glow, which, with brass electrodes, is green, and, with platina, grey in color. The duration of the entire phenomena is from ·000017 to ·000050 seconds—*i. e.*, 17 to 50 millionths of a second. The duration of the white and yellow light together, 6 to 8 millionths, and the duration of the white flash less than 24 hundred millionths of a second.

On the "Meteoric Shower" of the Total Eclipse of August 7, 1869, by Prof. Alfred M. Mayer. In the reports of Professors Morton and Himes on the Solar Eclipse of August 7, there appear remarks in reference to the appearance on the camera plate, of the telescope at Ottumwa, of bright points traversing the field of view. Other unofficial accounts, given in the Journal, refer to the phenomenon observed at other stations.

During the month of September, 1869, I was engaged in running a meridian line for the foundations and piers of the Sayre Obser-

vatory, of which I have charge; and on the afternoon of two days, while taking altitudes of the sun with a theodolite, I observed bright, star-like points rush into the sun's image with about the apparent velocity of shooting-stars. The similitude to a meteoric shower was perfect, even to the *trails* left by many, while others appeared to burn out before they reached the sun's limb.

The display was so *artistic* that I called my assistant's attention to it as a beautiful pictorial illustration of Mayer's theory of the maintenance of the sun's heat.

I immediately referred it to its real cause, viz: the flights of minute insects across the field of view. The supposition was confirmed, on withdrawing my eye from the ocular, by observing clouds of minute flies or midges, with thin iridescent wings, flashing in the light of the sun.

Although more of interest to naturalists than to astronomers I will add that on two evenings of the past week while examining the moon, between the hours of 8 and 11, I have seen birds crossing the moon's image, (which entirely covered the field of view,) at the rate of about 8 in a minute. They were all going eastward.

Errata in Prof. Mayer's Report on the Eclipse of August 7, 1869. (See October number of *Journal*.)

Page 258, line 14 from bottom, for Plate III. read Plate II.
" 260, " 10 " top, " *four* read 41.
" " " 18 " " " *sideral* read sidereal.
" 262, " 16 " " " *node* read mode.
" 263, " 11 " bottom, " *numbra* read umbra.
" " " 7 " " " *ocular* read ocular.
" 265, " 20 " top, " 40 read 50.
" 266, " 15 " " " 40 read 50.
" 274 " 7 " " " *were* read was.

On Plate I. *dele* Instantaneous.
On Plate III. for 027 inch read ·027 inch.

Spectrum of the Aurora, Zodiacal Light, &c.—In connection with the observations of Prof. Young, during the late eclipse, the following translation from a few paragraphs in the text accompanying Angström's chart of the solar spectrum may be of interest.

On page 42, he says, after some introductory remarks: "In fact, during the winter of 1867–8, I have been able to observe, repeatedly, the spectrum of the luminous arc bordering the obscure segment, and always seen during the feeble auroras. Its light is almost monochromatic, and consists of *a single brilliant ray*, situ-

ated to the left of the well-known group of calcium lines. By measuring the distance from this group, I have determined the wave-length of this ray, which is found equal to $\lambda = 5567$.

Beside this ray, of which the intensity is relatively great, I have observed, also, by widening the slit of the spectroscope, traces of three lines extending almost as far as F.

On a single occasion, when the luminous arc was agitated by undulations which changed its shape, I saw regions momentarily illuminated by certain feeble spectral rays; but, taking into account the intensity of these rays, I would, nevertheless, say that the light of the luminous arc is sensibly monochromatic.

There is a circumstance which gives to this observation of the aurora spectrum a much greater importance, and, indeed, a cosmical character.

During one week of March, 1867, I succeeded in observing this same spectral ray in the zodiacal light which then presented itself with an intensity truly extraordinary for the latitude of Upsal.

Finally, when during a starlight night, all the sky was, in a certain sense, phosphorescent, I found traces of it in the feeble light emitted by all parts of the firmament.

A very notable fact is, that this remarkable ray does not correspond with any of the known rays of simple or compound gases, so far, at least, as I have studied them up to this time.

It follows, from what I have said, that an intense aurora, such as may be seen above the polar circle, would probably give a more complicated spectrum than that which I have found. Granting this, we may hope that an opportunity will be afforded of explaining the origin of the rays already found, and the nature of the phenomenon itself. Not being able to give this explanation at present, I propose to return to it at another time."

Remarkable Aerolite.—Dr. Neumayer recently presented a paper to the Imperial Academy at Berlin, detailing the facts relating to the fall of a meteor a short time ago, at Krähenburg. The fall took place in the day-time, and so great was the velocity of the mass, that it buried itself two feet deep in the sandstone rock. It was dug out while still warm, and found to weigh 31½ pounds. So great was the noise caused by the rushing of the aerolite at planetary velocity through the air, that it unnerved those people who stood near the spot where it fell, and the sound was heard over a radius of thirteen miles.—*Mech. Mag.*

Civil and Mechanical Engineering.

PUMPING ENGINES.

By W. M. Henderson, Hydraulic Engineer.

This subject has attracted considerable attention in the columns of the *Franklin Institute Journal*, dating from the introductory article on "Cornish Pumping Engines," published in the July number of 1868. Up to the present time, the pre-eminence then claimed for that description of engine has been successfully maintained, if, in forming an opinion, we are to be governed by the fact developed in the course of the discussions following the article in question. Throughout the several papers contributed, it has been generally conceded, that the Cornish Engine must invariably be superior in economy of working, theoretically and practically, to any possible rotative engine for pumping purposes.

Early in the discussion it was intimated that there was yet another engine, based upon reciprocating parts, without a fly-wheel, which possessed the capacity of rivaling the Cornish in its best results, without the requirements of magnitude demanded by that engine. The mere mention of such an engine, however, was all the information that could be gained by subsequent solicitation from the author of that remark. Later articles in reference to the same engine, which have appeared in the columns of the Journal, show a reticence in regard to enlightening us, as to the means employed, by which the economical results claimed are to be obtained, or any disposition to describe the principles upon which the said engine is constructed. There should not exist any occasion for this, as truth will be rendered more lucid by investigation, as gold is purified by the searching power of heat in the crucible.

The economical supply of water to large cities is a matter at all times of the utmost importance, and there is a grave responsibility attached to the selection of a pumping engine, when the quantity of water to be raised is counted by the half million gallons of water per hour. We should not be blindly led by theories advanced by interested parties in favor of any particular description of engine, without the exercise of sound, deliberate judgment, based upon the most accurate information to be obtained. Is it reasonable to expect that we shall find this knowledge, peculiar to the mathematician

and educated engineer, whose whole life has been devoted to the study of problems, kindred to this, in a body of politicians and other gentlemen, whose talents do not run in that particular direction? There will always be a certain degree of importance attached to the action of such a body, however, from the dignity of the position occupied, their recent decision to retest the old experiment of low expansion, upon a high scale, has prompted the inquiry as to whether this engine, lately ordered by them, possesses any new features, not before known, whereby the great merit claimed for it in point of economy, has any existence in fact.

In the absence of more authenticated information, we will briefly review the apparent points governing the case, prefacing our remarks with a general outline of the construction of the engines alluded to, as designed for the new water-works now building at West Philadelphia. These engines will be a duplicate pair of Duplex engines, containing in all eight steam cylinders and four pumps, each pair to be composed of two distinct engines, arranged side by side, and calculated to work at right angles, or at quarter-stroke to each other. There is first a high pressure cylinder of 29 inches diameter, to the rear of which is bolted a low pressure cylinder of 50 inches diameter, a single piston rod passing through both is continued into the pump, which is 22 inches diameter, the stroke of all being 4 feet. The latter is situated in front of the high pressure cylinders, with a space between the two, to allow of the working of a double bell crank, in shape of an inverted T, for operating the engine valves, as also the air-pumps; a rock-shaft passes through the head of the T, and motion is communicated to the tail of the same, by a short link, driven from a cross-head pin, secured to the centre of the piston-rod, playing between the stuffing-boxes of the pump and high pressure cylinder; each end of the head of the T, drives a single acting air-pump. These are placed in a pit immediately beneath the bell cranks, the inner ends of the rock-shafts are furnished with crank-arms, from which rods give motion to upper rock-shafts carrying arms for giving the necessary motion to the slide-valves. These rods cross each other, and connect to the upper rock-shafts of the opposite engine, by which means each engine, having the necessary position, works direct the slide-valves of its neighbor, (a motion originally invented by one Jonathan Dickson, about thirty years ago). Each cylinder is provided with a steam chest and slide-valve, operated by a valve-stem common to both,

the high pressure steam-chest is elevated to the level of that upon the low pressure cylinder by strut steam ports, a steam pipe conveys the exhaust steam from the high to the low pressure steam chest, and another the final exhaust from the latter to the condenser, situated in the air-pump pit.

The steam from the boiler follows full stroke in the high pressure cylinder, and is then admitted to the low pressure cylinder, there to act by expansion.

It will be at once apparent, that the high pressure cylinder becomes the measure for expansion, being in fact a cut-off cylinder for the other. Were we to expand the same volume of steam in a single cylinder, having an area equal to the two combined, we would produce a gain of mechanical effect equal to about 11¼ per cent. above that obtained by the combination, besides effecting a large saving of exposed condensing surfaces. To render this more plain, let us follow the action of the steam in both cases. In the combined arrangement, the steam acts with a full pressure upon the area of the smaller piston from the commencement to the end of its stroke, at the same time, the charge from the previous stroke is admitted to the low pressure cylinder. But as the steam in expanding within this cylinder, reacts with a back pressure upon the piston of that of the high pressure, seeing that a communication between the two must necessarily be kept open, the effective area of the expansion cylinder will be reduced by the extent of area presented by that cylinder, it will also be observed that as the expansion is going on, the high pressure piston follows it up completely to the end of the stroke, when the whole of the steam will be imprisoned within the larger cylinder. By comparing the relative capacities of these two cylinders, we shall find that the steam will have been expanded three times, corresponding to cutting-off at one-fourth stroke, in a single cylinder, whose area is equal to the aggregate of the two. As the case stands, the single cylinder will have a gain of mechanical effect over its rival equal, as before stated, to about 11¼ per cent. On the other hand, the compound engine will have performed its work with a marked regularity of motion, consequent upon a more uniform distribution of the force employed, as made known to us by Woolf about the beginning of the present century. Economy in the results is what we are after, however. An engine working without any expansion will undoubtedly work more steadily than either of them, but economy

will be exactly in proportion to the number of times the steam is expanded. When steam is admitted throughout the whole stroke, its efficiency is, of course, equal to that of unity, when cut off at one-third the effect will be as 1 is to 2·099, at one-sixth as 1 is to 2·792, at one-tenth as 1 is to 3·3.

Again, the propriety of using two cylinders, when one can be made to answer, is open to serious objections, not the least of which are increased frictional, and condensing surfaces, sources for loss of power, which all intelligent engineers are fully alive to. But for these, and other inherent objections, afterwards to be noticed, we probably have the reason why the engine gained no notoriety in England, the country where its essential features were fully developed. There are cases where the compound principle may be used with advantage; as, for instance, where a very high degree of expansion is required, too great to be safely employed in a single cylinder, owing to the blow which would be given to the piston by the introduction of highly compressed steam when cutting off at an extremely early part of the stroke. In such a case the principle is clearly admissable, for the steam has then two cylinders to expand through, and the cutting-off point in the first one need not exceed that which has been found safe in practice.

Within ordinary limits the Cornish beam engine will be found to answer all requirements, as a very large proportion of the initial force is absorbed in overcoming the inertia of the heavy beam, which thus becomes a reservoir of surplus force, to be given out during the latter part of the stroke when the steam is attenuated by expansion, the result is that a comparatively steady velocity is maintained throughout, much to the advantage of the engine, as well as to the operation of the pump. The whole secret of successful working lies in the proportioning of the gravity of the moving mass, in accordance with the degree of expansion employed. As an instance pointing conclusively to the importance attached to this matter, I would state a case where two large expansive engines, of nearly the same size, working near each other, one of which had an open net work beam weighing about 30 tons, the other a strong heavy beam of 45 tons weight, the difference of the working of the two was very perceptible, while the duty performed by that possessing the heavy beam was nearly five million pounds greater than the other.

Returning to the subject of compound engines, we are reminded

of an argument advanced by some, that the great economy attending their use, has been found to proceed from the fact of the steam being used twice over. In answer to this remarkable statement, I would simply add, that the feat of expending a dollar, and still retaining it, has never yet been successfully accomplished. Any person possessed with sufficient intelligence to comprehend the nature of the case, must be at once impressed with the fact that a duplication of frictional resistance, and extension of condensing surfaces, should never be resorted to, without some special object, and a clear proof that the adopted evils will be counterbalanced by a greater gain accruing from the innovation itself. And this gain must be one of economy, not economy of first cost, but of fuel, which is the true standard by which the worth of any such machine must ultimately be estimated. The true expense of an engine is the original price, added to its annual cost, capitalized say at twenty years purchase. To make the most out of the fuel then becomes our imperative duty, and this, it has been decided, can only be done by using the steam with as high a degree of expansion as can be safely obtained. The expanding of steam three times is not such an extreme case, as to require two cylinders to accomplish it. On the contrary, it is far short of the limit to which the principle has been extended in the single cylinder of the Cornish Engine. Many of these work regularly cutting off at one-sixth of the stroke, and that, too, with the attraction of gravity acting in their favor, by doing actual work, instead of grinding along an endless plane of horizontal obstacles.*

It may be argued that the rate of expansion is not limited to cutting off at one-third of the stroke, as in this case, but may be extended to any point, by increasing the initial pressure of the steam, together with the diameter of the low pressure cylinder. This manner of testing the expansive principle of steam, by increasing the area instead of the length of the cylinder, as has been heretofore the practice, possesses at least the merit of novelty. There is one objection to it, however, of rather a serious nature, and that is the great loss sustained by condensation, which will occur at the moment the steam passes from the high to the low pressure cylinder.

* In one case where a duty was recorded of 128,000,000 of pounds of water, raised one foot high by the consumption of 112 pounds of coal, the steam was cut off about one-tenth or one-twelfth of the stroke, while in Woolf's combined cylinder engines, the steam has been expanded as high as twenty times.

Here, it is manifest, a very sudden expansion takes place, by the steam having to diffuse itself over a greatly increased area. In the present case this area is three times greater than that which confined the steam an instant before. Steam, expanding in this manner, is always accompanied by a fall of temperature due to the disappearance of heat in overcoming the cohesion of the vapor particles, producing liquefaction, and this will be continued to the end of the stroke, partly from the abstraction and conduction of heat by the metal of the cylinder itself, assuming temperatures intermediate between those of the steam at the beginning, and at the end of expansion, as well as from the effect due to the expansion of the steam, in doing the work of driving the piston.

The quantity of steam liquefied at the early part of the stroke, from the cause stated, may be greater than that due to the expansive working of the piston, especially as each end of the cylinder has become thoroughly chilled from contact with the frigorific influence of the condenser, just before the charge of steam is let in from the cut-off cylinder.

It is plain any increase of diameter of the low pressure cylinder, for the purposes mentioned, but increases the evil pro-ratio as the square, and that any considerable change in the relative diameters of the two cylinders, will seriously affect the one prominent feature possessed, *i.e.*, the uniformity of present effect.

Besides this internal condensation, there is yet to be added that produced by the increased surface exposed to external condensation, two cylinders in place of one, with an extra steam chest, strut steam ports, and a long steam pipe for conveying the steam from the extreme end of one cylinder to the other. This excess of external condensing surfaces, it is estimated, will be about 40 per cent. above that of the single cylinder arrangement. What the sum total of these losses will amount to it would be difficult to determine, but that they are of a ruinous nature is very apparent, and must consume a considerable amount of coal to be maintained.

While upon this subject, I would like to draw attention to a statement made by Mr. Lean, in his report, upon the engines in Cornwall, compiled at the request of the British Association for the Advancement of Science. "The duty of the best pumping engines in Cornwall far exceeds what could be effected, were it even possible to apply the force of the steam immediately to the water, unincumbered by the friction and imperfection of machinery, or the

loss arising from accidental condensation." This remarkable statement is perfectly valid, when we bring forward the great gain derived from the expansion of the steam in the Cornish Engine. Supposing that the force of the steam could be applied directly to the water in the suction pipe, that there shall be no loss by condensation, and a perfect vacuum maintained above the column of water to be lifted, then allowing that 112 pounds of coal will convert 15 cubic feet of water into steam of 50 pounds pressure to the square inch, which is equal to an evaporation of 8·37 pounds of water per pound of coal (the best Welsh coal will evaporate 9·5 pounds). At this pressure the volume of steam, compared to that of the water, from which it is generated, is 435 times greater. Then $15 \times 435 = 6525$ cubic feet of steam $\times$ 144 square inches, and by 50 pounds pressure = 47,000,000, about one-half only of the duty performed by the best engines in Cornwall, as will be seen by referring to the figures below.

By the advantages offered in the expansive principle of steam, we are enabled to overcome all the defects incurred from friction, and imperfection of the machinery, together with the losses arising from the accidental leakage of the valves and connections, with the attending condensation, and still double upon the theoretical effect that would be produced by using steam non-expansively.

Tabular Duty of Cornish Pumping Engines.

Fowey Consuls	50 inch	130·2 M.
Holmbush	80 "	122·4 M.
East London Water-works		105·7 M.

The average duty of the whole year 1855, as given in Brown's report:—

Austin's	80-inch	at Fowey Consuls	98·6 M.
Treffry's	"	at Par Consuls	98·5 M.
Darlington's	"	at Great Polgooth	93·9 M.

The highest duty ever recorded for any continuous period has been awarded to Taylor's 80-inch at the United Mines in Gwennap, viz: 128 M.

The average duty of fifteen engines at the Cornish Mines, taken monthly for a whole year, was 70 M., which is also the average duty of the best Cornish Engines belonging to the London Water-works. I would here reiterate a statement made at the conclusion

of my previous article on "Cornish Pumping Engines," that any improvement, looking to further economy, above that afforded by that class, may be found in the possible adaptation of the compound principle, applied to the Cornish type. At some future day, I may call attention to the design of such an engine, should my daily labors permit.

The above list of the duty performed by the Cornish Engines referred to, is respectfully offered as a matter for comparison in the forthcoming test of this other engine, based upon reciprocating parts, without a fly-wheel, which, it is claimed, has the capacity of rivaling the Cornish in its best results.

Philadelphia Hydraulic Works, Oct. 1st, 1869.

Casting Cylinders for Pneumatic Piles to be used in the Omaha and Leavenworth Bridges. In a letter just received from Mr. Robert Cartwright, of the Boomer Bridge Works, Chicago, he says as follows:—

"We have made 132 piles in all, and have only lost two during the time. Yesterday we made the 101st perfect cylinder *consecutively*, one each working day. The cylinders are $1\frac{3}{4}$ inch thick, 8 feet 6 inches diameter and 10 feet long. By the process, it is simply impossible to have them of unequal thickness. In the arrangement of the moulds, I am enabled to cast them without having to replace the brick of mould. By simply putting on fresh loam on the brick mould (which is well vented) I get a smooth exterior, the cylinder generally coming out of the mould and leaving it as perfect as before iron was poured in. The core barrel is usually all drawn out in an hour after the casting is poured. We cast at 5 P. M. and lift cylinder out at 7 A. M. next morning. We make them without *sinking head* and have no trouble in getting them perfect. By means of a shaft and tunnel to moulds, the casting is cooled rapidly, and the core being removed so soon, the strain resulting from *shrink* is entirely obviated, none of them ever having shown the least sign of a crack, or an alteration of shape from a perfect circle. The greatest variation of diameter we ever had was $\frac{3}{16}$ inch, and that was during the first products of the moulds, until we got the right allowance for ferro-static pressure."

This letter was accompanied by several very interesting photographs, one showing a train of twelve long cars each carrying one of these tubes, and reaching from the foreground into the dim distance.

BELTING FACTS AND FIGURES.

By J. H. Cooper.

(Continued from page 239.)

Paper Belting.

The Messrs. Crane Bros., of Westfield, Mass., who manufacture Crane's Patent Paper Belting, have kindly furnished me with the following facts concerning their new fabric for driving belts. "Our belts are manufactured from pure linen stock, and can be made of any desired thickness, width and length; we guarantee equal driving power from equal surface, as from leather or gum, and we recommend them only for straight and unshifted belts, making none less than five inches wide. They will not stretch nor change shape, and being made all in one piece, of even thickness, will run smoothly and straight. We have proved them equal in durability with leather, and equal also in strength, where they have been arranged for one to pull against the other. They adhere to the pulleys very closely, and generate no electricity while running. They are quite flexible, and do not crack in passing over pulleys even as small as six inches in diameter. They are not affected by heat at ordinary temperatures, nor by dust or oil, but will not run in water; being very tough, they would answer a good purpose for elevator belts, holding the bolts well and running in a direct line without swinging from side to side.

"Compounds similar to those used for stuffing leather belts, or black lead, mixed with sperm oil, are very good to apply to our belts, when dry and slipping.

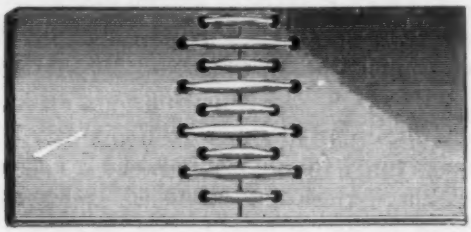
"For *endless* and for *heavy belts*, our belting material is not to be surpassed, and when fitted to the pulleys at the proper length, it must remain so until worn out. It is 40 per cent. cheaper than leather, and for all heavy and expensive belts must come into general use."

Directions for Lacing Paper Belting.

"For narrow belts butt the two ends together, make two rows of holes in each end (thus obtaining a double hold), and lace with lacing leather, as here shown.

"For wide belts, where extra strength is required, rivet pieces equal in length to width of belt on back of each end, and make the connection with lacing, as before. This belting should, in all cases,

be put on by the use of clamps, secured firmly to each end of the belt, and drawn together by bolts running parallel with and outside the edge of the belt, making no allowance for stretch.



Wide belts, in dry places, can best be connected with Wilson's Belt Hooks, riveting down the teeth, thus making a connection that will not wear out."

We present some facts derived from testimonials furnished to the makers of the paper belting.

One party says the 15-inch paper belt gives us entire satisfaction; it drives all our machinery with perfect ease; runs very straight, without any swaying or sagging; is not affected by temperature; and there are no indications of electricity, which we consider a great gain.

Another party have a 15-inch belt, 70 feet long, in use during 15 months; the surface next to pulley is hardly marked, and shows no indications of wear; belt not touched, since first put on, for repairs of any kind.

Another party says: "We have been using one of your 14-inch Paper Belts for the last 4 months to drive a paper engine, which requires about 13 horse-power. It works to our entire satisfaction, and gives us less trouble than any other belt in the mill."

Another party has in use a paper belt 12 inches wide, 50 feet long, and runs from the fly-wheel of a 25 horse-power engine to a pulley on line shaft, driving machinery which nearly exhausts the power of the engine. It gives equal satisfaction with a leather belt formerly used in same place. A narrower and shorter belt, crossed also, has done quite as well as a leather belt under like circumstances.

Another party have thoroughly tested the paper belt, and are entirely satisfied therewith. The belts are 12 inches wide; one 120 feet long, the other 92 feet; they do not stretch or slip.

Another party says: "The Paper Belt continues to give good

satisfaction; it has already been at work on our engine as long as the majority of leather belts last in the same place, and as yet we can see no signs of wear. It does not stretch nor slip, and running in the open air, as it does, it saves us a great deal of trouble which we have had heretofore with a leather belt. Having had a great deal of experience, we do not hesitate in saying that the Paper is a superior Belt."

Belts and Pulleys.

"We would not venture to prophesy that belts will continue for ever in general use, especially if made of leather, in the old way. Nor is our faith in the perpetuity of small pulleys very resolute. Robertson's frictional gearing seems to work more steadily than belts; but if pulleys are large, the friction of their faces against each other is sufficient for most work, and they will run with less power than belts or Robertson's gearing. To make pulleys work well against each other, they must be turned with more truth than is usual; and the shafting must be better lined; and there must be something elastic in the journal-boxes, such as a little rubber, to press the pulleys together.

"The vibration or chattering of lathes is probably due to the spring of the belts, more than to the spring of the metal of the lathes. So far as this is the case, the frictional gearing, of either kind, will get rid of it.

"In driving fans there is frequent trouble with belts, and there is more expense than need be; and the noise and vibration are evidences of serious imperfection, which, perhaps, is unavoidable when a soft material is used that cannot have an exact shape.

"A friend of ours proposes to use steel belts for certain cases, such as fans. The steel must be welded perfectly, and must be of mild quality, and the pulleys must be large, to make them work well. Steel belts would run with less power than leather, because the power exerted in bending them would be restored when they straightened themselves; but leather does not return much of the power required to bend it around the pulley." * * * *Amer. Artizan*, Aug. 2, '65, p. 201.

Leather Belts.

"A friend of ours who has had experience in tanning leather for belts, and has conversed about belts with many machinists, and is familiar with their experience, assures us that the adhesion of belts

is much better when the hair side is against the pulleys, and that the belt used in this way is more durable. The belt will not crack on the flesh side so readily as on the hair side, and seldom cracks at all, if the hair side is against the pulley. He has known cases in which belts slipped and would not do the work required of them when the flesh side was against the pulley; but when they were turned hair side to the pulleys they ceased to slip, and did much more work than they could do with the flesh side to the pulleys. His theory is, that the belt, as well as the pulley, adheres best when smooth, and the hair side adheres best because it is smoothest."—*Am. Artizan*, Aug. 16, '65, p. 234.

Belts.

"The effective radius of a pulley is equal to the radius of the pulley added to one-half the thickness of the belt.

"In ordinary cases a belt will last about three years.

"Leather belts must be well protected against water, and even moisture.

"India rubber is the proper substance for belts exposed to the weather, as it does not absorb moisture and stretch and decay.

"It is quite probable that these belts will increase in popularity among manufacturers.

"In joining the ends of a belt, it is generally considered best to cut small holes through the ends and lace them with a leather strap.

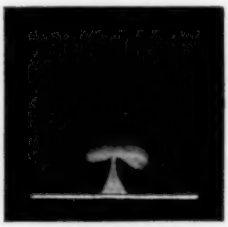
"It is found, in practice, that belts should not be subjected to a strain of over 300 pounds per square inch of section.

"Good belting of $\frac{3}{16}$ inches thick will sustain a strain of 50 pounds per inch width without risk, and without serious wear, for a considerable time."—*Am. Artizan*, July 1, '68, p. 394.

(To be continued.)

Plumbago as a Lubricant.—Every one knows that for heavy machinery plumbago is a good lubricant, but every one does not always think of applying it where it would serve best. It may thus be of value to some of our readers to know that Mr. Thomas Shaw found that a planer whose bed-plate required the force of eight men to slide it when lubricated with the best ordinary material, could be easily shifted with one hand when plumbago of good quality was applied.

Fig. 1.

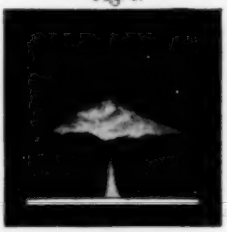


July 1. 3h 20m
S. W. Limb
Height=38"

Fig. 2.

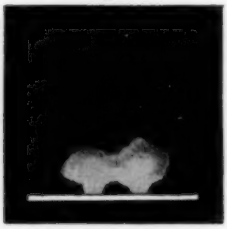
July 1. 3h 45m
N. E. Limb
Height=120"

Fig. 4.



July 2nd 11h 35m
Position angle 278°
Height=65"

Fig. 5.

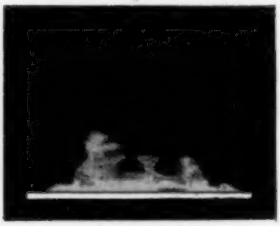


July 4. 9h 0m
S. E. Limb
Height =40"

Fig 7.

July 4. 5h 30m
E. S. E. Limb
Height=35"

Fig. 8.



July 4 5h 45m
N. E Limb
Height=40"

Mechanics, Physics, and Chemistry.

OBSERVATIONS OF THE SOLAR PROTUBERANCES.

By Prof. F. Zöllner.

From the Report of the Royal Saxon Academy of Sciences. Translated from the *Astronomische Nachrichten*, No. 1769. August, 1869, by Alfred M. Mayer, Ph. D.

With my method (communicated to the Royal Society of Sciences, at Leipsic, at the session of the mathematical and physical class of the 6th Feb.), which I have been unable to apply until now, on account of the incomplete arrangement of instruments, I have just observed protuberances with *great sharpness and clearness.* Their shape and general character is approximately represented in the accompanying drawings.

From the nature of the method, the *same* protuberance was simultaneously observed in three different colors, corresponding to the three homogeneous lines of its spectrum. There is, however, a material difference between the red and blue image on the one hand, and the yellow on the other. The latter is very intense only in close proximity to the edge of the sun's disc, and in this respect corresponds to the other images, while the more delicate details disappear at a greater distance. This difference does not seem to be caused by the greater brightness of the spectrum in that region, but appears to depend on one of the two following hypotheses for an explanation:—

Either that the rays which give rise to the yellow image emanate from a gas having a greater specific gravity than hydrogen, and therefore existing at a lower level,

Or, that the greater intensities of temperature and pressure nearer the surface of the sun cause hydrogen to emit these rays.

The first protuberance which I observed, is represented by Fig. 1. Above an intensely luminous peak-shaped mass, rising from the border of the sun, is spread a cloud-like formation of less intensity. To the same type belong the protuberances of Fig. 4 and Fig. 9. In Fig. 4 it was remarkable that the surprisingly beautiful cumulus-shape of the cloud was separated from the peak by a considerable distance. The cloud was exceedingly delicate, and even its

finest details could be recognized. The separate cumuli of which it was composed, appeared almost like dull luminous points.

One of the most remarkable formations was the second of the protuberances represented in Fig. 2. I hardly believed my eyes when I noticed in it the tongue-like motion of a flame. This motion was slower, however, compared with the size of the flame, than that of high, towering flames at great conflagrations. The time required by such a wave in passing from the base to the apex, was about 2 or 3 seconds. I endeavored on the following days to verify this observation by the discovery of similar formations, but I have not succeeded, in spite of my arduous and continued search. I therefore request that this statement may be considered as one requiring further proof.

Surprising examples of the great rapidity with which the protuberances change their form and intensity of light, are found in Figs. 3, 6 and 10. In these Figs. the different shapes are represented, which the same protuberance assumed after the intervals of Leipsic mean time stated under them. The heights mentioned beneath, in seconds, refer to the highest point of the protuberance.

The protuberance represented in Figs. 3 and 4 were observed simultaneously with Mr. Vogel, Assistant of the Leipsic Observatory, and our drawings have been found to agree.

If I may be allowed to compare the general impression of the protuberances, observed by me so far, with terrestrial phenomena, I will state that the great majority remind me of the different forms of our clouds and fog. The cumulus type is completely developed in the above mentioned cases. Other formations remind us of masses of clouds and fogs floating closely over lowlands and seas, whose upper parts are driven and torn by currents of air, and which present the well known ever-varying forms when viewed from the tops of high mountains.

All who have hitherto observed the protuberances through my instrument, agree in all material points with my comparisons concerning their general character.

An exception is seen in the flame-like protuberance of Fig. 2. On looking at Figs. 1, 3, 4, 9, and perhaps 5, the observer will unconsciously consider the part steeply rising from the border of the sun as the cause of the cloud above it. He is reminded of volcanic eruptions and thermal springs.

As far as clearness in the contrast of the image with the back-

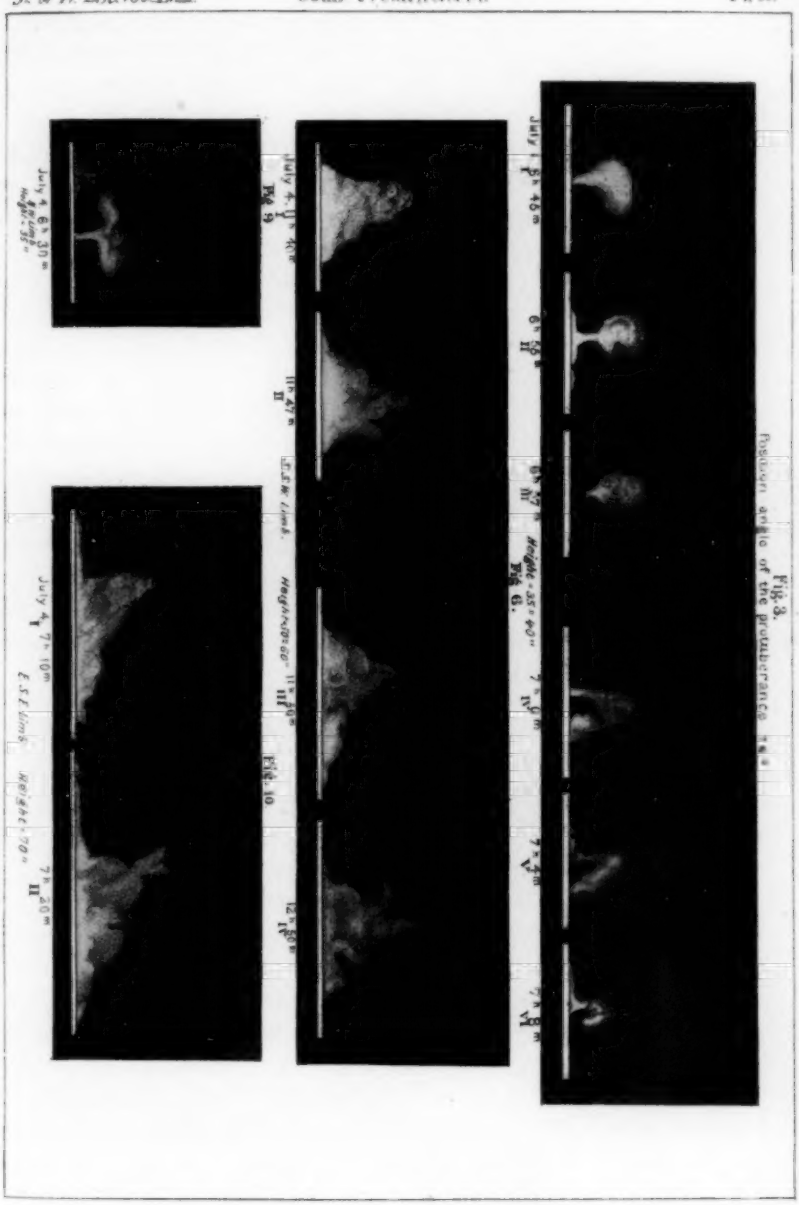


Fig. 3.
Position angle of the protuberance 74°.

ground is concerned, the method gives entire satisfaction. Even when the sun is but a few degrees in altitude, the outlines and details appear with a clearness which surprised all observers.

I am at present engaged in modifying this method so that the image situate in the blue portion of the spectrum can be photographed directly and thus multiplied.

If large prisms of considerable dispersive power could be procured, and an excellent clock-work connected with the instrument, the image of the sun could be diaphramed off and a circular slit used in the spectroscope. We would then be enabled to observe *simultaneously all* the protuberances on the limb of the sun, in the different parts of the spectrum, just as in a total solar eclipse of long duration.

Finally, I beg to make known an observation, which appears too remarkable to remain unmentioned, and which will be of great importance in extending our knowledge of the actions going on near the surface of the sun, if its explanation be found correct.

As early as the 27th of June, the first clear day after a long spell of cloudy weather, I observed the bright protuberance-lines without, however, being able on that day to make a complete observation of these formations. As soon as I approached the slit of the spectroscope to a certain position on the sun's limb, where the protuberance lines appeared particularly long and bright, bright linear flashes passed through the whole length of the dull spectrum *over* the limb of the sun, about 3 or 4 minutes distant from the latter. These flashes passed over the whole of the spectrum in the field of view, and became so intense at a certain point of the sun's limb as to produce the impression of a series of electrical discharges, rapidly succeeding one another, and passing through the whole of the spectrum in straight lines.

Mr. Vogel, who afterwards, for a short time, took part in these observations, found the same phenomenon at a different portion of the sun's limb, where protuberance lines also appeared.

This phenomenon can be explained by the hypothesis that small, intensely incandescent bodies moving near the surface of the sun, emit rays of all degrees of refrangibility, and produce flashes of a thread-like spectrum as their image passes before the slit of the spectroscope.

Leipsic, July, 1869.

ANALYSIS OF THE NATIVE PHOSPHATE OF LEAD FROM CHESTER COUNTY, PA.

By Charles P. Williams.

Though the lead-bearing veins near the line of junction of the mesozoic sandstone with gneiss, in Schuylkill and Charlestown townships, Chester County, have enriched mineralogical cabinets with many most remarkably beautiful specimens of pyromorphite, nothing has been published with reference to their chemical composition. The elaborate investigations of Prof. J. Lawrence Smith,* though extending through all the other species from the locality, fall short, I believe, from recording any analysis of the phosphates abounding thereat. It seems, of all American minerals, to have been the most neglected at the hands of chemists.

In 1863 the writer came in possession of a remarkably fine suite of the species from both the "Wheatley" and the "Chester County Mines," which had been collected by Joseph Cocking, who had been successively mining captain at both these works, and subsequently tributer at the latter. I have from time to time analyzed some of the specimens of pyromorphite, according to the following method:

The solution of the mineral was effected in nitric acid and the lead precipitated in the greatly diluted solution by means of a long continued current of sulphydric acid gas. The precipitate thus formed (after digestion with sulphide of ammonium to remove sulphide of arsenic if present), was converted into sulphate of lead and weighed as such. The solution in sulphide of ammonium was, after proper preparation, invariably examined for arsenic, but only in one instance was even a trace obtained of this metal.

The filtrate from the sulphide of lead was boiled for some time with the addition of nitric acid, the concentrated liquid neutralized with ammonia, acetic acid added and the whole boiled till the odor of acetic acid was no longer strongly noticeable. The precipitation of the ferric phosphate and of the fluoride of calcium was thus effected. The precipitate was weighed, fused with carbonate of soda, extracted with water, chloride calcium added to the aqueous solution, the precipitate separated, treated with acetic acid and the resulting fluoride of calcium weighed as such. This weight being deducted from the joint weight of the original precipitate gave the ferric phosphate, the composition of which was determined by dissolving the residue

* *Amer. Jour. Sci.*, II., XX., 245.

from the aqueous solution of the fused precipitate, in hydrochloric acid, adding citric acid, and precipitating the iron as sulphide by means of sulphide of ammonium. The sulphide of iron, converted into ferric oxide and weighed, and the weight deducted from the weight of the original precipitate minus the fluoride of calcium, gave by difference the amount of phosphoric acid carried down in combination with the oxide of iron. In the calculation of the final result the ferric oxide was, of course, reduced to its equivalent in ferrous oxide. To obtain satisfactory results at this stage of the operation, it was found that an amount of mineral of not less than three grammes weight was required to be taken. This, of course, gave troublesome amounts of precipitates in the previous and succeeding stages, and the results therein obtained were usually controlled by operations on smaller quantities in which the precipitates by ammonia and acetic acid were simply separated and weighed without any attempt at their analysis.

From the filtrate from the above, the lime was first removed as an oxalate, in an acetic acid solution, by means of oxalate of ammonia, and the phosphoric acid then precipitated by the ordinary magnesian mixture. The precipitates of phosphate of ammonio-magnesia were always redissolved and reprecipitated by ammonia. To the amount of the phosphoric acid thus obtained was added the small amount of phosphoric acid obtained by the difference in the separation of the constituents of the precipitate by ammonia and acetic acid.

The chlorine was estimated in a separate portion of the original mineral. In calculating the results for a rational expression of the analysis, the amount of lead required for the chlorine, being expressed in terms of oxide, was deducted from the total oxide of lead (calculated from the sulphate) and the remainder of the oxide was taken as tribasic phosphate. The ferrous oxide was also assumed as existing in the same condition and the joint quantities of phosphoric acid required for these bases, deducted from the total obtained phosphoric acid, gave a remainder from which was calculated the phosphate of lime ($3\,CaO\,PO_5$). In all my analyses the theoretical amount of lime thus required (independent, of course, of that in combination with the fluorine which was directly determined) was less than that actually obtained. In the case of analysis No. 1 this discrepancy is the greatest, amounting to 0·21 per cent. Is it that the oxide of iron does not exist as a phosphate or does the ex-

cess of lime result from the presence of some calcareous mineral associated with the pyromorphite? The discrepancies in the amounts of lime have been disregarded in the table of results below given.

The following three analyses are of specimens from the "Chester County" Vein and represent the three most common shades of the mineral from this locality. No. I. was of dark olive-green color, No. II. was of a yellowish-green shade, and No. III. approximated more closely to II. than to I., though still darker than the former. The analyses are of the mineral dried at 212° Fahr.

	No. I.	No. II.	No. III.
Phosphate Lead ($3\ PbO\ PO_5$)	87·40	85·89	87·01
Phosphate Lime ($3\ CaO\ PO_5$)	·37	2·64	Trace (?)
Ferrous Phosphate ($3\ FeO\ PO_5$)	1·74	·62	1·39
Chloride Lead (Pb Cl)	9·79	9·41	9·13
Fluoride Calcium (Ca F)	·34	·67	·91
Arseniate Lead	None.	Trace.	None.
Matter insoluble in Acid	·42	Trace.	Trace.
	100·06	99·23	98·44*
[Excess of Lime	·21	·11	·15]

* In analysis No. III. there was a trifling loss of PO_5.

By operating on 29·167 grammes of pyromorphite from the same locality, and carefully conducting the cupellation of the button of lead obtained, I obtained a button of silver weighing ·0011 grammes, equivalent to ·0037 per cent. metallic silver, probably existing as chloride and as such replacing some of the chloride of lead. This amount (equivalent to $1\frac{1}{5}$ oz. of silver to the ton, of 2,000 pounds, of similar ore) falls considerably below that obtained in the practical working of the so-called phosphate ore from this mine, but as this ore, as sold to the smelting works, was largely intermixed with galena, it is probable the excess of silver resulted from the galena.

Philadelphia, October 7th, 1869.

COMPOSITION OF THE NATIVE GOLD FROM VENEZUELA.

Communicated by CHAS. P. WILLIAMS.

SINCE the time of the ill-fated expedition of Sir Walter Raleigh to the Orinoco, down to the year 1865, nothing had been done towards the systematic exploration of the supposed existing auriferous region, situated in the State of Spanish Guayana to the south of that river, in the Republic of Venezuela. In that year Mr. L. M. Davis (then a student in my laboratory) was sent, under the auspices of J. B. Austin, Esq., formerly of this city, but who had for some years previously been a resident of Venezuela, to explore the mineral deposits of Guayana, and the result of his exploration has been the commencement of systematic and vigorous mining operations, which have resulted successfully, and which are now sending to the United States alone upwards of $50,000 of gold monthly. The gold from this State is remarkable for its fineness. Mr. Davis has just completed, in my laboratory, the following analysis of a specimen (weighing 1·1114 grammes):

Gold	93·583 per cent.
Silver	3·637 "
Iron	1·600 "
Copper	·650 "
	99·470

A careful examination was made for platinum and associated metals, but no traces were discovered.

The specimen analyzed was from a placer in the bed of the Quebrada de Peru, department of Yuruari, Neuava Providencia or Caratal.

But little is being done towards working the placers (which are reported as being remarkably rich) the whole product of gold being obtained by operations on a system of quartz veins, containing but little pyrites. The upper portions of the veins consist of an auriferous gossan which is highly manganiferous, and from which gelatinous silica separates on treatment with acid. I hope soon to complete an analysis of this interesting gossan.

Philadelphia, Oct. 16th, 1869.

ON VARIOUS PROCESSES FOR PRESERVING TIMBER.

UNDER the above heading, there appeared in the last September edition of the *Journal of the Franklin Institute*, an article written by Dr. Adolph Ott, in which I have been, unfortunately, honored by the author, in mentioning my invention. He says:—

"*The Process of S. Beer.*

"Quite recently attention has been called to a process for preserving timber, invented by S. Beer, in New York. The same consists in the treatment of the wood in a boiling solution of borax in water, and came to our knowledge through a German periodical of last year. It is claimed therein, that all putrefiable substances are effectually removed by the borax; moreover, it is held that the ligneous fascicles become harder and less absorbent; that the treatment protects all the wood from insects; keeps it dry and inflammable. The process is carried on in the following manner." (Here follows a very defective description of my process.)

I thankfully accept the conceded inventorship of the borax process, but I am quite at a loss to comprehend why Dr. A. Ott was forced to hunt up a provincial periodical published for the Grand Duchy of Hesse, from last year, to get a knowledge of this American invention, a full and correct description of which is easily found in the New York papers, such as the *Scientific American*, *Artizan*, and others, or by application at the Patent Office in Washington, or at my own office, especially when it is known that he was personally introduced to me over a year ago, shortly after my American patent was issued, on which occasion he offered his kind services as a correspondent for American and foreign papers, to write upon this very invention. His offer I politely declined, because I did not want talk, but work, to further my invention. After an imperfect description of my process, he enters into the following criticism:—

"Let us now examine the process a little closer. The fact that borax is soluble in about 12 parts of its weight of cold water, makes this process inapplicable for structures which are to be exposed to terrestrial or meteoric waters, for the reason that the *intended protective coating* will be slowly removed."

No greater wrong could be done than representing me in the eyes of the readers of the *Journal* as using a protective coating by my process. I know too well the uselessness of any coating to preserve wood, because, if the fermentive matter is left in wood, it will decay within; and if the sap is removed from wood, then coating is quite unnecessary, as pure wood cannot rot, whatever may be its exposure to water or air, or both together.

My process, I have described to consist in removing the putres-

cible or nitrogenized sap-matter from wood altogether by means of borax, or some like compound, which effectually dissolves and extracts such matter without injuring the wood fibre. It is expressly stated in the specification of my patent, that the wood, after it had been treated with a solution of borax, "may be several times washed in boiling water, which will extract the absorbed borax in connection with the colored matter and restore the wood to its former color and appearance." Although borax is itself an antiseptic substance, I am very particular to wash out its last traces, because I know that there is no antiseptic equal in its antiseptic power to pure wood. The fact alone that there exist pieces of wood which are several thousand years old, without any other preparation than having been deprived of sap by washing in water during their transportation in the old slow way of rowing the timber on streams, proves that pure wood resists alteration more than any coating known. That my opinion herein is fully sustained by scientific researches, investigated first by De Saussure, and since then confirmed by all our celebrated chemists, will be seen by the following excerpts:—

"Wood, especially when under the influence of atmospheric vicissitudes, is rendered liable to decay from the decomposition of its albuminous* component; this circumstance favors the growth of lichen and fungi, and encourages the ravages of insects to which the albuminous portions in particular offer the means of nutriment."—William Allen Miller's *Elements of Chemistry*, Part III., page 95.

"*The spontaneous decomposition of the vegetable albumen, acting as a ferment, is the primary cause* of the decomposition *of wood.* Hence it is found that those woods which contain the smallest quantity of albumen and amylaceous matters are the most durable."

"If the decay of wood is, in the first place, an induced effect of the contact of decomposing albumen, a means of preserving the wood is naturally suggested in the removal of the albumen, or else in so modifying it, by causing it to combine with other substances, that it shall no longer possess the property of decomposing spontaneously. The solubility of albumen, in cold or tepid water, affords a

* All fermentive or putrescible substances are called, in science, "albuminous or nitrogenized" matters, because they contain nitrogen as an elementary component, which is the very element which renders such organic compounds liable to spontaneous decomposition. Wood substance contains no nitrogen, while the sap consists mainly of nitrogenized matters.

simple means of withdrawing from the wood this element of decomposition. Unless the wood is in very thin pieces, the removal of the albumen by the process of washing in water is extremely slow. To test the efficacy of merely washing in water, equal weights of washed and unwashed wood equally dry, were moistened with the same quantity of water, and the amount evaporated was replaced in each quantity equally. In the course of a few weeks the unwashed wood was always found to be covered with a thick mold, while none appeared on the washed wood. At the expiration of six months, the unwashed wood was found to have sensibly diminished in weight, while the weight of the washed wood remained unaltered."—Dr. Boucherie. This is literally copied from *Applied Chemistry*, by E. A. Parnell, Vol. I., p. 185. London: 1854.

Dr. Ott continues:—

"Again, borax being of a hygroscopic nature, if not refined with the utmost care, will soon absorb water, and thus leave the wood in a damp instead of a dry state. Naturalists, in selecting (!) borax crystals, well know that they have to coat them with a varnish, or otherwise they would soon become white or opaque, on account of their affinity to water."

It is true that borax crystals slightly effervesce on the surface, but Dr. A. Ott cannot really suppose that such effervescence is caused by affinity to and absorption of water. On the contrary, it is due to a drying up and loss of part of the water of crystallization. He must also know that hygroscopic salts are those which dissolve in their own weight of water, or less, and which melt (deliquesce) by absorbing the moisture of the air. Now, Dr. Ott himself states that borax wants twelve times its weight of water to dissolve: how can he represent borax as a hygroscopic salt? Indeed, Dr. Ott must very much underrate the intelligence of the readers of the *Journal* by his bold assertions, contradictory not only to knowledge, but also to common sense. He continues:—

"But a still more serious objection against the process consists in the property of alkaline fluids, such as a solution of borax, of dissolving, or at least attacking, certain substances of the wood upon which its strength, solidity, and toughness, and other desired properties greatly depend. These substances are the so-called incrustating materials (!). They form in concentric layers the inner walls of the ligneous cells, they being abundant in the hard wood and the stems of fruits, where they often fill the entire space of the cell. In the making of paper from wood, all that is wanted is the supple, pliant cell. The manufacturer's attention is therefore directed to the removal of the non fibrous bodies, which end he accomplishes by the boiling of the previously reduced wood in alkaline lyes; but the paper attained, though smooth and elastic, and capable of taking the highest finish, lacks that degree of firmness necessary to make it a fitting material for the better kinds of paper."

Borax, phosphate of soda, and some other like compounds, form a distinct class of salts, which, although being partly of a slightly alkaline reaction, differ very materially from caustic and carbonate alkalies, by being agencies for dissolving organic matters without in the least attacking or affecting the structural tissues or cellular membranes, however tender such may be, and however strong and in excess the solutions of these salts may be applied. By this their peculiar property, long known to chemists, I found them admirably adapted for seasoning, preserving and purifying wood; and my invention consists in applying the salts of this class for the purpose stated. I prefer to use borax, although I distinctly claimed the use of all like compounds, because borax is the most efficient, and thereby the cheapest salt, and because it gives to wood a much superior finish than any other; and lastly, because it is easily re-worked, and can be used over and over again.

An experiment, which is as interesting as it is illustrative, I will state here. The white of an egg well mixed with a solution of borax, and heated to boiling, will become clear thereby without coagulation, and all the tender cellular membranes (tela cellulosa) will settle on the bottom without being dissolved, however strong the solution may be, or however long the boiling is continued.

Paper-makers who use wood, would do well to dispense with potash or soda, and obtain a license to use borax, or a like compound, to purify wood from its non-fibrous matter; and I had them mainly in view in claiming the right of my process for purifying wood also. So much to dispel the fear which Dr. Ott may have caused in the minds of the readers of the *Journal* by his fancy that borax acts as a destructive agent, like potash or soda. He further says:—

"In the course of this article, I shall have occasion to dwell fully on the importance of the natural resin contained in timber, in its bearing on the durability of wood. It is certainly not an advantageous feature of the above-described process, that the resin is altogether removed by it."

If it is true that the natural resin is very important for the durability of timber, how could wood decay with the natural resin therein? Resinous bodies, even gum copal, change by exposure to air and moisture. In the most favorable case they can only postpone the decay of wood. Weak solutions of borax, sufficiently strong to remove the soluble portions from wood, do not

much affect the natural resin in pine and spruce wood, as I know by experience; and, if desired, it is at will in the hands of the operator to leave it therein, though its presence is of no visible utility in our case.

He finally says:—

"In regard to its claimed superiority in withdrawing the putrescible substances, it may be stated, ON GOOD AUTHORITY, (experiments conducted at the College of the City of New York,) that 14 per cent. of albumen from the quantity originally contained in the wood, have been retained in SAW-DUST, after boiling the same several times, and each time FOUR HOURS, with a saturated solution of borax."

If true, this would be fatal to my invention, as only 86 per cent. of the albuminous matters would then be removed, while I claim to remove all.* The question is, what is his "good authority?" Prof. Doremus, and his assistant, Dr. O. Loew, are the only experimentalists in the laboratory of the College of the City of New York. Their ability, expertness, and veracity cannot be questioned. They both flatly deny their authority for such statement; and, to expose the love of truth of Dr. Adolph Ott, by his desire to enlighten the readers of the *Journal* on the subject, I publish the following letter:—

"NEW YORK, *September 29th*, 1869.

"SIGISMUND BEER, ESQ.

"Dear Sir:—Pieces of wood, prepared according to your process by a solution of borax, have been carefully analyzed by me over a year ago, to ascertain the quantity of nitrogen retained. I found only weak traces of nitrogen therein, although I had used common Croton water for solution and washing. The same wood, unprepared, contained nearly 1½ per cent. of nitrogen. The whole process of extracting the sap from the wood was performed in less than two hours.

"O. LOEW, *Assistant in the College of New York.*"

In conclusion, I may be allowed to indulge in a few general remarks concerning the subject in question. Decayed wood, when compared with wood in the sound state, shows an alteration in its substance. Such change is a purely chemical one, and brings the decay of wood within the category of a chemical process, which is always based on certain conditions, necessary to its accomplish-

* Weak traces of nitrogen are found in every organic substance when analyzed; they are only accidentally present, but they amount to nothing. Even distilled water contains traces of ammonium, and more will not be found in wood properly Beerized.

ment. By chemical investigation we know that the transformations occurring during decay of wood, are caused by the albuminous matter distributed over the cellular tissues, acting as a ferment, while in a state of spontaneous decomposition. Wood, therefore, which has been deprived of its albumen, has lost thereby its capacity to decay or rot. Surely it cannot be altered or decomposed by mere exposure to the combined action of water and air, so destructive to unprepared wood; and it is in this sense that I adopt the expression of our European critics, that by my preparation "wood is rendered practically indestructible."

Still, it is not preservation alone which wood advantageously acquires by my treatment. Other improved properties, which I may mention here, are *its increased strength* and *closer structure*, from the absence of foreign matter which, in ordinarily seasoned wood, distends its tissues, and furthers the quality of being more perfectly dried, without any loss from "shakes," and rendered unsusceptible to atmospheric changes consequent to the total removal of deliquescent matters. When I have added that the expenses are so trifling that the licensed Lumber Yard in Twenty-second street, near North River, New York City, is enabled to sell Beerized lumber at as low a price as ordinary dried stuff of the same quality, the progressive reader, acquainted with the squandering and destructive practice hitherto in use for curing lumber, will undoubtedly join in my confidence of a general adoption of the new plan at no distant time.

SIGISMUND BEER.

ON THE NEW CHEMICAL NOMENCLATURE.

BY DR. ADOLPH OTT.

(Continued from page 132.)

WITHOUT entering into the phraseology adopted by the adherents of the phlogistic theory, it is proposed to give an account of the changes effected in the nomenclature by the study of the properties of aeriform bodies, which precedes the great epoch in the history of chemistry inaugurated by ANTOINE LAURENT LAVOISIER, and denominated by the author of the History of the Inductive Sciences, the epoch of the theory of oxygen. The merit of having made the first attempt towards the introduction of a more rational nomenclature is due to MAEGNER and BAUME. To them we owe the change

by which the names of metallic salts are designated by the name of the acid and of the metal entering into their composition, that all the salts which are formed by the union of a metal and sulphuric acid, or oil of vitriol, are called *vitriols;* and *nitres*, if the latter acid is replaced by nitric acid. To TORBERN BERGMAN, then Professor at Upsala, in Sweden, chemistry owes a further attempt towards a more convenient set of names. They were first published in the UPSALA TRANSACTIONS, issued separately in 1782, and inserted in his work "Essays Physical and Chemical." Edinburgh, 1791.

"I am not ignorant" he says, in Vol. I., p. 11, "that words, like money, possess an ideal value, and that great danger of confusion may be apprehended from a change of names; in the meantime, it cannot be denied that chemistry, like the other sciences, was formerly filled with improper names." The names of salts of alkalies, earths and metals were composed by Bergman of a noun substantive to indicate the base, and an adjective to designate the acid, viz:

Alkali minerale phosphoratum for Phosphate of soda.
" " *nitratum* for nitrate of soda.
" " *aëratum* for Carbonate of Soda.
Alkali vegetabile vitriolatum for Sulphate of potassa.
" " *salitum* for Chloride of potassium.
" " *saccharatum** for Oxalate of potassa.

The earths were distinguished as *terra ponderosa*, *calx*, *magnesia*, *argilla*, and *terra silicea*.

The names of these salts were formed in the same manner as those of the salts of the alkalies, viz: *calx saccharata*, *magnesia*, *boraxata*, *terra ponderosa*, *aërata*, &c. The metallic salts were named according to the same principle, viz: *stannum salitum*, *nickolum nitratum*, *cuprum acetatum*, *ferrum aëratum*. As to the other suggestions of Bergman, we must refer the reader to the above cited work. The article "Nomenclature" in Watts' Dictionary of Chemistry may also be consulted with advantage. While these and other changes were proposed, GUYTON DE MORVEAU, an accomplished lawyer at Dijon, France, and at the same time an enthusiastic student of the natural sciences, had formed another system of nomenclature, and it seems independent of Bergman. It was first published in the May number of the *Journal de Physique* of 1782, which, strange

* The discovery of the fact that sugar, in being treated with nitric acid, yields oxalic acid, is due to Bergman. It was the first instance of the artificial formation of an organic acid. Scheele proved, afterwards, that this acid was identical with the acid of the common sorrel.

as it may seem, was then the vehicle of the opinions and views of Stahl and Becker, the founders of the phlogistic school. DE MORVEAU, however, at that time, had not yet become a convert to the Lavoisierian theory.

The following is a specimen of Guyton de Morveau's system of chemical nomenclature:—

ACIDES.	SELS.	BASES.
Vitriolique,	*Vitriols,*	*Phlogistique,*
Nitreux,	*Nitres,*	*Calce,*
Arsenical,	*Arseniates,*	*Baryte,*
Boracin,	*Boraxs,*	*Cuivre.*
Fluorique,	*Fluors,*	*Argent,*
Citronien,	*Citrates,*	*Platine,*
Oxalique,	*Oxalates,*	*Mercure,*
Sebacé	*Sébates,*	*Esprit de vin.*

In the meantime, the oxygen theory made its way with unexpected rapidity among the best savans of the time. BERTHOLLET, already an eminent chemist, and known for his researches on the composition of ammonia and the fulminate of gold and silver,* solemnly renounced the phlogistic theory in 1785.

Indeed, it was soon so generally adopted in France, that Fourcroy promulgated its doctrines under the name of "*La chimie francaise,*" a title which Lavoisier did not altogether relish. The extraordinary eloquence and success of Fourcroy as a lecturer at the Jardin des Plantes, had no small share in the diffusion of the oxygen theory; and the name of "the apostle of the new chemistry" which was first given him in ridicule, was justly held by him to be a glorious distinction.†

In England, the pneumatic doctrine was propagated by Cavendish, Kirwan, Nicholson, Tennant; in Germany by Hernebstädt, Girtanner, Klaproth and von Humboldt; in Holland by van Troostwyck and Lauwerenburg; in Italy by Spallanzani and Volta; in Spain by Proust and others.

* Fourcroy, in his "General System of Chemical Knowledge," asserts that Berthollet discovered also the real nature of the pretended "*dephlogisticated marine acid,*" or chlorine gas. This needs correction. It was discovered by Scheele in 1774, and considered by him as a simple body. Berthollet, however, at the time of the publication of the above cited work (1804), still held it to be a compound of muriatic acid gas and oxygen, which explains the name "*oxymuriatic gas,*" met with in the older chemical books. Since 1808, according to Davy, M. M. Gay Lussac, Thénard and Curandau laid claim to the ideas of "oxymuriatic gas" being a simple body, and of muriatic acid gas being composed of this substance and hydrogen; but these opinions, he adds justly, were stated by the illustrious discoverer in 1774.

† Cuvier, Eloges, I., p. 20. Whewell, History of the Inductive Sciences, II., 278. Third Ed.

At the close of the year 1786, Guyton de Morveau was invited to Paris to witness the latest experiments of Lavoisier; and becoming convinced of the truth of his views, he joined with the illustrious investigator for the purpose of producing a nomenclature which should be in harmony with the discovered facts. Fourcroy and Berthollet having been associated with them, they published jointly, in 1787, their "*Methode de Nomenclature Chimique*," which must forever be considered as immensely beneficial to the science of chemistry as then known. When it is considered that a new scheme of notation was formed at the same time, Fourcroy could justly claim "that students derived so much advantage from this new classification of objects so faithfully represented and, as it were, delineated before their eyes, and rendered striking to the imagination by the nomenclature, that the study of the science became as easy and simple as it had before been complicated and difficult."*

The French system is based upon the proposition that all substances which cannot be resolved into different bodies must be regarded as elementary, and that the names of compound-bodies ought to designate the elements which they contain, and also, if possible, their relative proportions. Oxygen, being considered at that time the only body capable of producing acids, the compounds of oxygen were subdivided into "primitive binary oxides," "variable binary oxides," and "acidifiable binary oxides." Water, or oxide of hydrogen was the only substance reckoned to the first class. In the second division, most metallic oxides were included, and in the third the mineral acids. The latter were again distinguished by specific names, terminating in *eux*, or *ique*, respectively, according to the quantity of oxygen they contained; *e. g.*, *acide sulfureux*, *acide sulfurique; acide nitreux*, *acide nitrique*. When the appellations of acids terminated in *eux*, the names of metallic and other salts formed by them were made to end in *ite;* and in *ate* when the acid ended in *ique*. Thus were formed, *sulfite d' ammoniaque*, or *sulfite ammoniacal*, *nitrate de soude*, *phosphate de soude*, *carbonate de baryte*, *&c.*

Thomas Thomson, in 1804, introduced the terms *protoxide*, *deutoxide*, *peroxide*, in order to distinguish the various stages of oxidation. This was one of the earliest improvements. The then known organic acids received arbitrary appellations, this system being not applicable for compounds consisting of elements united in various propor-

* Fourcroy's General System of Chemical Knowledge, I., p. 68.

tions. Thus originated the names: *acide suberique*, *acide succinique*, *acide formique*, &c. However, of a later date are the prefixes *per* and *hypo* in addition to the terminations *ic* and *ous*, *ate* and *ite;* the use of numerical prefixes, such as *di*, *tri*, *sesqui;* the substitution of *—uret* in—*ide*, the substitution of the names of the alkali metals and alkali earth metals for those of their oxides in the nomenclature of the corresponding oxygen salts, and many others, to which attention will be called in time.

(To be continued.)

MORTON'S EJECTOR CONDENSER.

[Report of Experiments at Ryesholm Pit, near Dalry, Ayrshire.]

By W. J. Macquorn Rankine, C. E., F. R. S., &c.—11 September, 1869.

I.—*General Description of the Engine.*

The engine on which the following experiments were made is a single cylindered double-acting horizontal steam engine. It drives a fly-wheel shaft, which, by means of a crank and connecting-rod, and a pair of bell-crank levers, works a pair of pumps for raising water from a pit. The work done by the engine at a given speed is thus practically constant. During the experiments a uniform speed of 22 revolutions per minute was kept up; and the indicated horse-power was 24½. The cylinder is without a steam jacket, consequently some heat is wasted through condensation and re-evaporation in the cylinder, which might be saved if there were a jacket. Throughout the experiments the engine was worked at full steam, the admission going on from the beginning to the end of the stroke. The diagrams taken show a fall of pressure at the end of the stroke to the extent of about 3 lbs. on the square inch, below the initial pressure; and this is one of the effects of condensation in the cylinder. They also show a gradual formation of the vacuum, during the earlier part of the return stroke; and this is an effect of the re-evaporation of water previously liquified in the cylinder through the want of a steam jacket. The engine was originally non-condensing, and was converted into a condensing engine by the addition of an Ejector-Condenser.

II. *Principal Dimensions of the Engine.*

Stroke	4½ feet.
Diameter of cylinder	18 inches.
Area of piston (allowing for half piston rod)	252 square inches. = 1·75 square feet.
Space swept by piston per revolution	15·75 cubic feet.
Space swept per minute at 22 revolutions	346·5 cubic feet.
Mean speed of piston, at 22 revolutions per minute	198 feet per min.

III.—*General Description of the Experiments.*

The engine being kept working at the before-mentioned steady speed of 22 revolutions per minute, the quantity of water discharged from the condensing apparatus was measured by means of a suitable guage; and the rise of temperature of that water was ascertained by comparing together two thermometers, one in the cold well and the other in the hot well. Thus were obtained data for calculating the total expenditure of steam, from its heating effect on the condensation water. Indicator diagrams were also taken to show the power, and the pressure and vacuum in the cylinder when working as a condensing engine. The exhaust pipe of the cylinder was then disconnected from the condensing apparatus, and made to discharge the exhaust steam into the air. The engine was thus made to work as a non-condensing engine, at the same speed and against the same load as formerly; and indicator diagrams were taken to show the pressure in the cylinder under these circumstances. All the diagrams showed the same mean effective pressure, viz: 16·2 lb. on the square inch; and the same power, viz: 24½ I. H. P. The boiler pressure, as shown by the steam guage, ranged from 29 to 32 lbs. on the square inch above the atmosphere; but in all the experiments, whether with or without condensation, the pressure in the cylinder was greatly reduced by means of the throttle valve. The vacuum gauge, when condensation was used, remained almost perfectly steady at 24 inches = 11·76 lb. on the square inch; and this is sensibly identical with the greatest vacuum shown by each of the diagrams.

IV.—*Experiments made without Condensation.*

Initial pressure of steam lbs. on the square inch above atmosphere	19·
Final pressure, ditto	16·
Weight of steam expended in lbs. per hour, as calculated from final pressure in cylinder	1578·
Ditto in lbs. per I. H. P. per hour	64·4
Weight of steam expended in lbs per hour, as calculated from initial pressure in cylinder	1731·
Ditto per I. H. P. per hour	70·7

V.—*Experiments made with Condensation.*

Initial pressure of steam lbs. on the square inch above atmosphere	9·
Final pressure, ditto	6·
Vaccum at end of exhaust, lbs on the square inch	11·7
Weight of steam expended in lbs. per hour, as calculated from final pressure in cylinder	1086·
Ditto per I. H. P. per hour	44·3
Weight of steam expended in lbs. per hour, as calculated from initial pressure in cylinder	1234·
Ditto per I. H. P. per hour	50·3

Hence it appears that when the expenditure of steam is computed from the indicator diagrams, it is found to be reduced by the addition of the condensing apparatus to about *seven-tenths* of its previous amount, when the engine is doing the same work,—in other words, the saving is 30 per cent.

VI.—*Result of Experiments on the Condensation Water.*

The quantity of water discharged from the condensing apparatus was gauged by causing it to pass out of a tank through an accurately turned and measured circular orifice in a thin plate of sheet iron, and measuring the height above the centre of that orifice at which the surface of the water in the tank stood. The following are the data and results:—

Diameter of the orifice, inches	3·5
Total area in fractions of a square foot	0·06682
Effective area, the co efficient of contraction being 0·618	0·0412
Head of water in tank	1½ feet.
Velocity at contracted vein produced by that head, feet per second	9·04
Discharge, cubic feet per second	0·372
Do. do. per minute	22·32
Do. do. per hour	1339·2
Do. lbs. per hour	83430·
Temperature, cold well	52° Fahr.
Do. hot well	70° "
Difference	18° "
Units of heat (British) per hour given by the steam to the water, very nearly	1,5 2,000
Total heat of steam from 52° at 23·° (being the temperature corresponding to final pressure in cylinder). British units	1,131
Total steam condensed in lbs per hour, as calculated from effects on water of condensation	1328·
Ditto per I. H. P. per hour	54·2

The excess of the total expenditure of steam as thus computed, above the expenditure as shown by the diagrams, is to be accounted for mainly by condensation and re-evaporation in the cylinder which go on in all engines not provided with steam jackets.

VII.—*Further Comparisons of Expenditure of Steam.*

The calculations of the expenditure of steam in lbs. per hour, and in lbs. per indicated horse-power per hour, with and without condensation, are here recapitulated:—

	Lbs. Steam per Hour.	Lbs. Steam per I.H.P. per Hour.
With Condensation.		
A. Calculated from final pressure, as shown by diagram	1086	44·3
B. Calculated from initial pressure, as shown by diagram, the fall of pressure during admision being ascribed to liquefaction in the cylinder	1234	50·3
C. Calculated from effects on temperature of water discharged	1328	54·2
Without Condensation.		
D. Calculated from final pressure, as shown by diagram	1578	64·4
E. Calculated from initial pressure, as shown by diagram, the fall of pressure during admission being ascribed to liquefaction in the cylinder	1731	70·7

The difference between the numbers marked *B* and *C* in the preceding table, viz: 94 lbs. per hour, or 3·9 lbs. per indicated horse-power per hour, being 7 *per cent.* of the total expenditure of steam

marked *C*—represents the quantity of steam lost, or ineffectively expended, through the following causes:—

1. Filling cylinder-ports and clearance.
2. Liquefaction immediately on entering the cylinder (followed by re-evaporation during return-stroke).
3. Leakage past the packing of the piston.
4. Expenditure at the starting-jet of the condensing apparatus.

It is evident, however, that the first three causes alone are sufficient to account for the whole, or nearly the whole, of a waste of steam amounting to 7 per cent of the whole expenditure; and this is in accordance with the fact that, during the working of the engine, the cock of the starting-jet is kept so nearly closed that the escape through it must be almost inappreciable, being just sufficient to prevent the suction of air at the small hole in the cylinder of the self-acting piston-valve, by which the starting-jet is regulated.

When the engine was worked without condensation there were no means of measuring the total expenditure of steam, including waste, as there were when condensation was used. If we assume, however, an allowance which is commonly made in practice for clearance, leakage of piston, packing, &c., viz: 5 per cent., we obtain the following *probable* estimate of the total expenditure of steam *without condensation*:—

	Lbs. Steam per Hour.	Lbs. Steam. per I.H.P. per Hour.
E. Expenditure, as already calculated from initial pressure	1731	70·7
Add 5 per cent. for clearance, leakage, &c.	87	3·5
F Probable total expenditure without condensation	1818	74·2
G. Total expenditure with condensation, as before	1328	54·2
Difference, being net saving by the use of the Ejector-Condenser	490	20·0

Being 27 per cent. of the greater expenditure. This, however, is probably a low estimate of the savings, for it is based on a low estimate of the waste of steam in the non-condensing engine.

VIII.—*Useful Work.*

The useful work done by the engine is calculated from the following data:—

Diameter of bucket of each of the two pumps	10½ inches.
Stroke	4 feet.
Height of lift	25 fathoms = 150 "
Double strokes per minute, 5-9ths of number of revolutions of engine or	12⅔

The results are:—

Work, foot-lbs. per minute	550,368
Effective horse-power	16·68
Indicated horse-power, as already stated	24·5
Inefficiency, or ratio of effective to indicated power	0·68

That is to say, 34 per cent. of the indicated power is the power expended in overcoming the friction of the pistons, valves, mechanism

of engines and pumps, and pump plungers, and the resistance of pipes and valves to the motion of the water raised by the pumps.

IX.—*Conclusions.*

The principal conclusions to be drawn from the experiments are, that the use of the Ejector-Condenser effects a saving of steam, as compared with the expenditure of steam by the same engine when doing the same work without condensation, which certainly amounts to 27 per cent., and probably to 30 per cent.: that there is probably a greater proportionate saving in the fuel burned; for it is well known that a diminution in the absolute quantity of fuel burned in a boiler increases the proportionate evaporative power of the fuel, by diminishing the waste of heat: that there is a steady vacuum of 24 inches of mercury, or 11·75 lbs. on the square inch: that the expenditure of steam by the starting-jet is certainly very small, and probably almost inappreciable: that the condensing apparatus is easily manageable and not liable to get out of order: and that it has been added to the engine without requiring any addition to the size of the engine-house, and without causing any inconvenience by the space which it occupies there.

It may be remarked that the present example of the Ejector-Condenser, having been originally intended for a larger engine, discharges a quantity of water greater than is absolutely necessary for the condensation of the steam, and therefore at a lower temperature than if the condenser had been specially designed for the engine; and that it therefore does not show the advantages of the Ejector-Condenser to their full extent.

THE U. S. CABINET OF PRACTICAL GEOLOGY AND MINING.

Under the direction of the Commissioner of the General Land Office, the Hon. Jos. S. Wilson, a cabinet has been organized at the seat of the government, for the collection and preservation of a complete system of geological and mineralogical memorials of the whole country, especially of the public domain, and an alcove surmounted by the coat of arms of each State has been assigned for the preservation of the particular specimens of each State and Territory. The special organization of the cabinet was put in charge of Mr. A. R. Roessler, formerly connected with the geological survey of Texas, and member of the Imperial Geological Institution of Vienna. The specimens have been arranged on scientific and systematic bases looking to the presentation of a synopsis of the principal geological subdivisions with the different periods and epochs upon a

regular scale. The cabinet illustrates the character of the minerals from every part of the country, and the government will be enabled to collect more reliable statistics and more accurate general information than can be obtained by any other method; it includes the mineral products of the whole country, so arranged as to give at a glance an idea of the resources of each State and Territory, viz: 1st. A series of all the ores, native metals, useful minerals, coal, salt, sulphur, mineral waters, limestone, marls, native fertilizers, fire clays, building materials, &c. 2d. A collection of all specimens that throw light on the geological structure of the country, such as fossils and lithological or rock specimens. 3d. It is in contemplation to collect models of all mining and metallurgical machinery, implements, apparatus and specimens of all the various products of metallurgical processes, such as regulus and mat, slags and other furnace products, dressed and concentrated ores, amalgams and tailings. 4th. Sections, models and working plans of mines, to illustrate the principles and practical application of mining engineering.

The brief career of this cabinet so far proves that it supplies a *want*, that it represents a great interest in the country, and it is already looked to by an industrial class, the mining population, equal in intelligence and importance to any other, for encouragement and assistance. To bestow this advantageously, the cabinet should be enlarged and supplied with the means and skill, to examine and report on the mineral products received. More especially are needed, large suites of domestic and foreign minerals for comparison, care being taken that any so obtained shall be authentically labelled and arranged according to the most approved scientific methods.

It is evident that to accommodate the enormous collections that will ultimately be made, a suitable building should be provided at the outset. This edifice should be erected especially for the purpose, inasmuch as there is nothing of the kind in Washington that could be made available. The suite of rooms in the General Land Office now devoted to the cabinet would hardly hold a fraction of the collections necessary to illustrate, even in an imperfect manner, the universal wealth of a territory so vast as the United States. The collections already made since the organization of this cabinet would fill such a place many times to overflowing. Besides this, the collections of the various government surveys and expeditions, now stored in the cellars of the Smithsonian Institution and in part elsewhere would belong legitimately to this cabinet.

To dwell on the necessity that exists for such an institution is perhaps hardly requisite. All the leading governments of Europe, where mining forms at all an important source of revenue to the country, possess their museums, and we are, of all the great powers, the only one without a mining bureau or cabinet. The United States are usually not in the rear of nations in the march of improvement or in the fostering of enterprise, calculated to advance the prosperity of the country. The dignity of the nation demands such a museum, it is needed because without it, it will be impossisible to obtain a clear idea of or accurate information regarding the mineral resources of all the States and Territories.

The reports of the Commissioner of Mining Statistics are good, so far as they go, but the system is a defective one; it does not cover half the ground, and the information is derived, at best, from imperfect data. Such a report loses half its value, from not being illustrated by specimens of the minerals and ores described. It is also too local in its character, describing the resources of but a limited region. But the cabinet will illustrate the character of the minerals from every part of the country; it is the first step in the right direction, and will be the natural outgrowth of the future National Bureau of Mines of the United States of America.

No department in the government is so well adapted to the organization of such a museum as the General Land Office, the beneficial influence of which never has been so deeply felt, since it has been under the direction of such a distinguished talent, as that of the Hon. Jos. S. Wilson. The nature of the occupation of its employees brings them more in contact with the miner and quarryman than any other of the officers of the government. They meet the miner in the field and possess an advantage in this respect over the Tax Collectors. The surveyor is usually also from his training, better qualified to collect suitable specimens understandingly. The ramifications of the Land Office extend into all, or nearly all the mining regions and its officers can, with but little additional labor, procure proper material for the formation of such a museum as the one contemplated.

The question will naturally arise in the minds of those acquainted with the subject—what benefits are to be gained? what good will come from the foundation of this museum? The benefits are numerous and varied. Through it, we will be able to obtain more accurate information than is possible at present, of the character

and relative value of the mineral products of all sections of the country, and more reliable statistics of our mineral wealth as a nation than by the present plan of the employment of a Commissioner of Mining Statistics. The government would be in constant communication with all persons in the country, who are in position to give accurate information on these subjects, and would not have to depend on the interested statements of mine owners and superintendents or of irresponsible parties, anxious to magnify the importance of their own districts at the expense of truth and the disparagement of their neighbors. It will enable the respective employees to utilize the results of government surveys and explorations, and to furnish to the government useful data on which to base mining legislation, in order to obtain in the most satisfactory and efficient manner, the revenue from this department of the national wealth.

Another result, and by no means the least that we foresee, is: the accumulation of reliable information on the subject of working metals, whereby the processes in each case can be ascertained. This will prevent the waste of many times the amount of money which the whole enterprise will cost.

Every year millions of dollars are thrown away in fruitless attempts to accomplish satisfactory results in the working of ores. This can never, of course, be entirely checked, though the more intelligent class of miners is anxious to learn, and many would avail themselves of these means of enlightenment who now work in the dark, simply because they have no means of knowing better.

We might go on detailing arguments in favor of the enlargement of the cabinet, almost *ad infinitum*, but we shall desist. The present cabinet has been built up without any appropriation from the government, and, comparatively small as it is, is an earnest of what can be done if the proper authorities lend a helping hand. We cannot but believe that Congress will take the matter in hand in a liberal spirit, if the members can only be made to understand the importance of the undertaking. We have in the new countries between the Pacific States on the west, and the eastern base of the Rocky Mountains on the east, a region large enough for an empire in itself, and abounding in minerals. Untold wealth awaits the labors of the hardy miner and demands that the government, whom the people has placed in the exalted position of trustee of all the interest, mining included, should provide what is necessary for the full development of the immense mineral resources of our country.

ON ELECTRICITY APPLIED TO REGISTERING VIBRATIONS.

By Prof. Le Roy C. Cooley.

In a recent number of this *Journal*, (January, 1869,) I described an *Electric Register*, with which, by the application of electricity, a direct registry of vibrations may be made in all cases where the motion has an appreciable amplitude. The possibility of studying the relation of the tones of stringed instruments was at the same time hinted, but the experiments in this direction were made without the precautions necessary to secure accuracy. They were then mentioned only to suggest this interesting application of the instrument, and the results, as they were unfortunately made to appear, were not such as to inspire confidence in the method. More careful experiments have since been made, and the actual pitch of *all the tones*, in a little less than *three octaves* of the piano, has been determined.

For a description of the registering instrument, and the method of making the necessary and delicate adjustments, the reader is referred to the former paper. A few words only may be here added to that explanation of its action.

The vibrations of the wire are made to occur in a vertical plane opening and closing an electric circuit with corresponding rapidity, and a dot is made upon the moving paper at the moment when the lowest point in the vibration is reached. The experiment begins when the wire is above its line of rest: the first dot, therefore, represents one-half of one complete vibration. Should the experiment end when the wire is at the highest point in its motion, the number of dots would show the exact number of complete vibrations made; but since it may end when the wire is at any point of its path, there may be a possible error of less than one-half of a complete vibration in an experiment one second in length. As the time is lengthened, the error is diminished; in a registry of five seconds the maximum error would be less than one-tenth of one vibration per second.

The precision with which the laws of vibration may be verified by the use of this instrument is in the highest degree satisfactory. However numerous the repetitions of an experiment may be, the registry varies only by a single dot. Moreover, it makes the law rest upon no comparison of sounds produced by the vibrations, nor upon any other effect of the motion, but upon the vibrations them-

selves, whose numerical relations are directly shown. Vibrations, sonorous or otherwise, are thus equally the subject of experimental investigation.

But to return to the experiments made upon the vibration of the piano wires, with a view to register the *standard pitch*, and, at the same time, to furnish the data upon which to study the numerical relations of the intervals in the scale.

Mr. Harwood, with Chickering Sons, Boston, very kindly transmitted the pitch of the *Boston Music Hall Organ* to Prof. T. Spencer Lloyd, of Albany, at whose request, also, Mr. G. N. Collier, with much care, put a piano in tune with that famous instrument. It may, therefore, be assumed that the piano whose vibrations have been registered represents the present standard pitch.

The piano, with its needle attachments, being in tune, and the register being carefully adjusted, a series of experiments, covering nearly three octaves was made, and the results, each being the mean of three experiments, are given in the following table.

This table of vibration differs from all others relating to music, so far as I know: first, in being the result of a *direct registry;* and second, in that it shows *all the intervals of the scale.*

1st Octave (lowest).		2d Octave.		3d Octave.	
NOTES.	No. of Vibs. per second.	NOTES.	No. of Vibs. per second.	NOTES.	No. of Vibs. per second.
C	30·8	C	61·5	C	123·1
C♯	32·7	C♯	65·5	C♯	130·8
D	34·7	D	69·3	D	138·5
D♯	36·7	D♯	73·4	D♯	146·7
E	38·7	E	77·4	E	154·7
F	41·8	F	83·5	F	166·6
F♯	44·2	F♯	88·3	F♯	176·5
G	46·8	G	93·5	G	187·1
G♯	49·4	G♯	98·7	G♯	197·4
A	52·2	A	104·4	A	208·5
A♯	54·4	A♯	108·7		
B	57·7	B	115·7		
C	61·5	C	123·1		

The octave above the last note (A = 208·5) in the above table, is the *la* usually referred to in describing the pitch of the orchestra.

It would, according to this registry, be produced by 417 *complete vibrations per second.*

In the time of Louis XIV., the pitch of this A was, according to Sauveur, 405 vibrations per second, while by the action of the Congress called together by the Society of Arts, at London, in 1860, it was 440. The same note sounded by Handel's tuning-fork (1740) is said to have been made by 416 vibrations per second. It will thus be seen, that while the present pitch is nearly one-half of a tone higher than that referred to by Sauveur, and considerably more than that interval lower than that of the London Congress, it agrees with the pitch adopted by Handel to within a single vibration.

EASY RULES FOR ASTRONOMICAL REFRACTION.

By Benjamin Smith Lyman.

In using the solar compass, as well as other astronomical instruments, the refraction of the atmosphere must be taken into account as changing the apparent place of the sun or other heavenly body. In the zenith, the apparent place of such a body is not affected by refraction, but everywhere else it is raised above the true place; little near the zenith, but more and more towards the horizon, and some thirty-five minutes at the horizon. The amount of displacement changes too with changes in the weight and heat of the air, as shown by the barometer and thermometer. Near the horizon the refraction is great and changes very fast with a small change of the true height or altitude; and as the rays of light then pass for a greater distance through the air, and through much of it quite near to the earth's surface, they are greatly exposed to change from variations along their path in the weight and heat of the air, variations that clearly must be quite unknown. Hence, astronomers say that no table of refraction can be depended on within five degrees of the horizon, although tables are given all the way from the zenith down to the horizon.

It is customary to calculate the refraction for any given height of a heavenly body, and for any state of the air, by means of these tables and by complicated formulas. But for the solar compass, which has no means of marking the refraction nearer than to full minutes, and, indeed, for sextants or other instruments that do not read closer than to five seconds, two or three very simple rules are as good as the tables for all heights above three degrees and

a-half; and observations should not be made lower than that, at any rate. These rules are very easy to remember, and by them the refraction can readily be calculated in the head.

The first rule is for the mean refraction—that is, the refraction when the barometer is at thirty inches and the thermometer at fifty degrees, Fahrenheit. *Add one degree and three-quarters* (1° 45′) *to the true altitude, and divide sixty-eight degrees* (68°) *by the sum; take one-half* ($\frac{1}{2}$) *from the quotient, and the remainder will be the number of minutes of mean refraction.* For example, to find the refraction for a true altitude of seven degrees and fifty-eight minutes:

$$\frac{68^\circ}{7^\circ\ 58' + 1^\circ\ 45} - \tfrac{1}{2} = \frac{68^\circ}{9^\circ\ 43'} - \tfrac{1}{2} = 7 - \tfrac{1}{2} = 6\tfrac{1}{2};$$

and the refraction is six minutes and a-half, exactly as given in the table of refraction in *Chauvenet's Astronomy* (1863). With an instrument, like the solar compass, that marks the refraction only to the nearest full minute, the whole number of the quotient will simply be taken as the refraction: as seven in the example just given. For plainly any quotient between seven and eight would answer to a refraction between six and a-half and seven and a-half —that is, in round numbers to seven.

The following table, chiefly for every odd half minute of refraction, shows the altitudes down to two degrees, for which these amounts of refraction are calculated by the rule, and the refraction for the same altitudes by the tables, and the difference between the two, or the error of the rule.

It is clear, that for any altitude above two degrees and a-half, the rule is quite exact enough for any instrument that does not read closer than half minutes, and from three degrees and a-half up to sixty degrees for any instrument that reads only to five seconds.

The second rule is for instruments that read to five seconds. *The mean refraction between the zenith and fifty-seven degrees* (57°) *altitude is eleven tenths of a second* (1.″1) *for every degree of distance from the zenith.* For example, the refraction at 75° of altitude is, by this rule 16.″5, or only one second more than is given in the tables, and this is the greatest error of the rule anywhere above 59°, and at 57° the error is only 1.″5.

The third rule is for the allowance to be made for changes of the barometer and thermometer, and is simply: *Add to the mean refraction at the rate of doubling for a rise of thirty inches in the barometer, or for a fall of five hundred degrees in the thermometer.* The refrac-

tion should, of course, be lessened at the same rate for a fall of the barometer or rise of the thermometer. For example, when the barometer is at 31·5 inches, and the thermometer at 75°, the mean refraction of ten minutes becomes $10 + \frac{1}{30} \times 1{\cdot}5 - \frac{1}{50} \times 25 = 10 + 0{\cdot}5 - 0{\cdot}5 = 10$; that is, it is unchanged. The rule is exact for the

TABLE I.

True Altitude.	Refraction.		Error of Rule.
	By Rule.	By Table.	
90° 0	0′ 14″·4	0′ 0″·0	+ 14″·4
68 0	0 28 ·5	0 23 ·6	+ 4 ·9
66 15	0 30 ·0	0 25 ·6	+ 4 ·4
60 0	0 36 ·0	0 33 ·6	+ 2 ·4
57 0	0 39 ·6	0 37 ·8	+ 1 ·8
32 15	1 30 ·0	1 32 ·0	— 2 ·0
20 55	2 30 0	2 31 ·0	— 1 ·0
15 15	3 30 ·0	3 29 ·7	+ 0 ·3
11 51	4 30 ·0	4 29 ·2	+ 0 ·8
9 35	5 30 ·0	5 29 ·3	+ 0 ·7
7 58	6 30 ·0	6 30 ·0	0 ·0
6 45	7 30 ·0	7 31 ·0	— 1 ·0
5 48	8 30 ·0	8 29 ·9	+ 0 ·1
5 3	9 30 ·0	9 32 ·3	— 2 ·3
4 26	10 30 ·0	10 31 ·0	— 1 ·0
3 55	11 30 ·0	11 29 .5	+ 0 ·5
3 29	12 30 ·0	12 28 ·5	+ 1 ·5
3 6	13 30 ·0	13 27 ·2	+ 2 ·8
2 47	14 30 ·0	14 40	— 10
2 30	15 30 ·0	15 19	— 11
2 15	16 30 ·0	16 9	— 21
2 2	17 30 ·0	16 58	— 32

barometer, and agrees with Chauvenet's tables, between fifty and a hundred degrees of the thermometer, but gives slightly too little refraction for a low state of the thermometer. This error, however, at ten degrees below zero is, according to Chauvenet's tables, only eighteen seconds for a mean refraction of ten minutes; and according to the tables given in *Norton's Astronomy*, is only eleven seconds. At zero, the error for the same mean refraction would be only fourteen seconds, by Chauvenet's tables. This rule, then, is

quite exact enough for any instrument that does not read closer than half minutes, and with all ordinary weather and altitudes, even for instruments that read to five seconds.

The following table gives the true and apparent altitudes down to five degrees for every odd half minute of mean refraction—that is, the altitudes at which the amount of refraction changes from one minute to the next, when only full minutes are taken account of, as in the solar compass.

TABLE II.

Altitude.		Refraction.	
True.	Apparent.	Exact.	Nearest Minute.
90° 0′	90° 0′	0′ 0″	
62 46	62 46	0 30	0
32 40	32 42	1 30	1
21 3	21 5	2 30	2
15 14	15 17	3 30	3
11 49	11 53	4 30	4
9 34	9 39	5 30	5
7 58	8 4	6 30	6
6 46	6 54	7 30	7
5 50	5 58	8 30	8
5 5	5 14	9 30	9
4 27	4 38	10 30	10

The foregoing tables have been made from the tables in *Chauvenet's Astronomy*, with the help, also, of the older ones given in *Norton's Astronomy* (edition of 1867).

135 South Fifth Street, Philadelphia.
10th September, 1869.

ON VARIOUS PROCESSES FOR PRESERVING TIMBER.

BY DR. ADOLPH OTT.

(Concluded from page 248.)

On the properties of resinous timber, and the unchangeability of resinous substances in general.

AMONG the various woods which are used either in house, ship-building, or other purposes, we meet some which, though even when not operated upon by chemical agencies, are renowned for their

extreme durability. It is especially wood of close texture that is rarely attacked. Moreover, it is known that wood rich in resin is extremely durable, withstanding the action of heat and moisture, when other kinds will soon decay. This fact seems already to have been known to the ancients, for Pliny says the more odoriferous timber is, the more durable it is.

The longer a tree has been used for pitch, the less durable is the timber that it yields; and it may be asserted that the wood of the coniferæ which is so useful for all kinds of carpenters' work, owes its qualities greatly to the large quantities of resin secreted in its tissues, they rendering it impermeable to water, and thus capable of withstanding its action. The resin becomes concrete after death by the evaporation of the essential oils which held it in solution. SCHACHT, in his splendid work, "*Der Baum*" (the tree), pp. 188 and 190, relates several instances of the wonderful durability of resinous timber. This author examined the ruins of the castle Ehrenstein, near Remda, Thuringia, one of the oldest extant in Germany, and found the wood (yellow pine), perfectly sound, and but a little turned brown. The old wood of the Canarian pine is also nearly imperishable on account of the resin diffused in its tissues. Schacht relates that the wood work of the column of the Patio and its galleries in the dwellings on Teneriffa and Gran Canaria, is as well preserved as if freshly felled. They were erected at the time of the Conquista, in 1402.

WILLIAM W. BATES, in the article already referred to, relates numerous instances of the great durability of resinous timber, among which the following may find a place here: the red and white pines of Oregon are largely used on the Pacific coast in the construction of the various parts of vessels. They are considered so well fitted for this purpose, that vessels have been constructed entirely from the denser sorts of pine timber, both in Oregon and California. The yellow, or long leaved pine of Virginia and North Carolina is extensively used by Atlantic ship-builders for planking, ceiling, stringers, beams, water ways, rails, keelsons, &c. It is very durable, and when a lighter, yet solid wood is required, it is preferred to oak of whatever kind. The white, or northern pine, according to Bates, is found at the head of the list of the softer woods used in building vessels of every description. For the construction of river steamboats it is invaluable, and is sometimes used in almost every part of the boat, except the frame, above light water mark.

No wood is said to be better adapted to withstand the sun and weather; for, with proper seasoning and reasonable protection, after the work is finished, it retains its properties as long as the best kind of oak. The wood of the hackmatack or tamarack (the American larch), which is known for its density as well as for its gummy nature, is used for vessels in every part. The sap-wood should of course be excluded in this, as well as in all other instances, but the heart wood requires no seasoning before use, the shrinkage in weight being less than two pounds per cubic foot. For lightness, strength, tenacity and durability it is unequalled. The red or Norway pine, when deprived of its sap-wood, is found to be a first-class material for top timbers, beams, deck planks, bulwarks, and ceiling; it affords excellent timber for masts, when large enough, and for all kind of small spars. The roots make very good knees and breast-hooks.

Another proof of the unchangeability of resinous matters is the amber, which formerly was considered as being of mineral origin, but is now decided upon to have secreted in a fluid state from the coniferæ of the upper tertiary and secondary strata. According to a mythe of the ancients, the Heliades, in weeping over the death of their brother Phaëton, were transformed by the gods into poplars, and their tears into amber. Indeed, it is a tear of times past, the remainder of a long gone luxuriant life, for this is shown by its constant occurrence with lignite and bituminous wood. From the fragments of vegetable organisms enclosed in it, it has been inferred that the flora of the northern hemisphere at that time must have been very similar to that of the northern part of the United States. GOEPPERT calls it the "amber flora." Amber enclosing wasps, ants and flies is quite abundant. Their frailest parts, as antennæ and legs are still well preserved, and spread naturally, while the insects which are so often noticed in the resinous exudations of our northern coniferous trees show always a bent body, crooked legs, and curled wings. This seems to show that the amber, unlike the rosin, must have passed very slowly from the fluid into the solid state. With respect to its chemical nature, it closely resembles the ordinary resins, but differs from them in yielding a peculiar acid, the succinic acid, in being treated with alkaline solutions. GOEPPERT succeeded in producing it artificially from Venetian turpentine, in digesting the same with twigs of the larch for twelve months in water of from 140 to 175 degrees Fah.

Additional proofs of the preservative action of resins may be gathered in a perusal of Joseph Pettigrew's work on the Egyptian mummies, in which it is conclusively proved that the bodies of the inhabitants of the Nile valley must have been impregnated with resinous and bituminous substances.

THE HEINEMANN PROCESS.

The foregoing remarks on the properties of resinous timber and the preservative action of resinous substances, have been considered necessary for the better understanding of a process which it is proposed now to examine. The same was invented by Mr. T. W. HEINEMANN, of New York, it being the one proposed to be adopted by the Street Commissioner of that city in the construction of the piers, docks, and bulkheads to be built by her corporation.

The inventor first expels the sap from the wood, so that the pores are left free and open for the injection of the preservative agent, which is common rosin, or colophony. The latter is introduced while in a liquid state, and under high pressure in vessels especially constructed for the purpose. From the appended letters of Professor R. OGDEN DOREMUS, of the City College, New York, it appears that one cubic foot of "green" wood absorbs on the average 8·96 pounds of rosin (the minimum being 3·39, the maximum 15·8), while one cubic foot of old, seasoned timber, absorbed but 2·66 pounds, or only one-third of the amount of the fresh one. I am not inclined to ascribe to these analyses a great value, for I am informed that the wood treated was neither of the same age, nor on the same site; but they show at least that the timber may be thoroughly impregnated by the process in question. According to the data given, green wood had absorbed sixteen per cent. in weight, while seasoned wood had taken up five per cent., both numbers indicating the average. These data might give rise to serious doubts as to the economy of the process, but we are informed that it is not intended to charge the wood in such a degree. However, common timber, such as hemlock, spruce and cotton wood, upon being treated with this process can be substituted for the hard and expensive oak and chestnut. Again, assuming, as we may properly do, that the injection with rosin will really preserve timber, the process must effect a vast saving by obviating the necessity of frequent reconstruction which at present is especially necessary for trestle work, railroad ties, and telegraph poles. Another important advantage

of the process consists in that, that the strength or resistance of strains, crosswise and compressive, is considerably increased. This fact has been ascertained by a series of experiments, some of which follow hereafter, and of itself enhances the value of the process.

TREATED WOOD.			UNTREATED WOOD.		
		Size 1 *in.* x $\frac{5}{16}$ *in.*			
Breaking Pressure	Quality	Grain	Breaking Pressure	Quality	Grain
163½ lbs.	Somewhat checked	Straight	98½ lbs.	Sound	Slant
193 "	Sound	"	103 "	"	"
171½ "	"	"	116 "	"	Straight
		Size ½ *in.* x $\frac{5}{16}$ *in.*			
72½ "	Checked	Straight	57½	"	"
57½ "	"	Cross	46	"	"
57½ "	"	"	46	"	"
		Size ½ *in.* x ⅜ *in.*			
121 "	Checked	Cross	71	"	large & straight
151½ "	"	Slant	84	"	"
121 "	Sound	"	71	"	"

We have no doubt that spruce, when treated by the Heinemann process, can advantageously be substituted for the more expensive kinds of yellow and white pine, and that the difference in cost will more than pay the outlay for the treatment. It seems to us to be especially fitted for ties, piers, bridges and wooden pavements. The blocks for these latter would remain water-tight, the crushing strength would be increased, and as to the preservative itself, we think that none more salubrious could be employed; to say the least, it is to be preferred to any ingredient having a strong, smoky, and disagreeable smell, as employed in certain alleged wood preserving processes.

One objection has been raised against the described method, viz.: that wood impregnated with rosin would be more inflammable than air-dried timber not treated. On this point, the inventor expresses himself as follows:—

"The impregnated tie is not more liable to injury by fire than one unimpregnated and properly seasoned. The first impression naturally is the reverse of this. Singular as this may appear, it is no less true. The inventor himself was not aware of this, until by accident he discovered it, and by repeated experiments demonstrated it. The *rationale* seems to be, that the rosin, which burns first alone, deposits, while burning, an air-tight coating of some uninflammable slag upon the surface of the tie, thereby preventing the fire from penetrating deeper. Combined with this, however, it is proposed

to use an inexpensive application which will make it almost fire-proof."

I will add that as yet no strictly uninflammable wood has come under my observation. So much as to the rosin process. Use alone can show whether the long searched for problem of the preservation of timber has been solved by it or not. Says our present Commissioner of Patents, the Hon. S. S. Fisher, in a decision lately given in a patent case: "If the means are inferior to the old way of doing the same thing, or inferior to other new ways, the invention sinks into obscurity and is soon forgotten. The best test of utility is use, and in the busy competition of trade this is soon applied, and the judgment of the inventor is affirmed or reversed by an inexorable tribunal."

LETTERS, ANALYSES, &C., OF PROFESSOR DOREMUS,
THE COLLEGE OF THE CITY OF NEW YORK,
June 19th, 1868.

Mr. THEO. WM. HEINEMANN:

Dear Sir,—I have nearly completed the investigation of your process for preserving wood by impregnation with rosin.

I am happy in reporting progress, to state that of the eight samples of wood which you brought for examination, viz.: pine, chestnut, white oak, elm, birch, maple, black ash and spruce, are all thoroughly saturated with rosin.

Six of these have been subjected to chemical analysis, portions being taken from the centre and from the circumference, with the following results —

One cubic foot of	fresh	Pine wood	contains.....	3·39	lbs of rosin.
"	"	"	Chestnut	"	.....	10·	"
"	"	dried	"	"	.....	13·5	"
"	"	"	Black Ash	"	.....	4·9	"
"	"	"	Maple	"	.....	2·993	"
"	"	fresh	White Oak	"	.....	15·8	"

The other samples are now being tested.

There is no question, therefore, but that you can completely impregnate the above-mentioned woods, and from these experiments, I conclude that you will be able to accomplish the same result with any variety of wood, by your ingenious process.

The advantages attained by your experiments are:—

That the wood will be permanently preserved from decay.

That owing to filling the pores completely with rosin, which is insoluble in water, foreign matters cannot gain entrance.

That though the pieces of wood are soft and easily worked shortly after saturation, in a few days they become exceedingly hard.

I have never before seen any process which would accomplish such a marvellous change.

Moreover, the apparatus required is not expensive. The process is simple. The rosin costs only about a cent a pound (that is such variety as you require), and but little fuel is necessary to fuse the rosin, and to generate the pressure necessary for impregnation.

I have the honor to remain, Yours, respectfully,

R. OGDEN DOREMUS, M. D.,

Prof. Chemistry and Toxicol. Bellevue Hosp. Med. College, and Professor Chemistry and Physics, College of City of New York.

THE COLLEGE OF THE CITY OF NEW YORK
July 11th, 1868.

Mr. THEO. W. HEINEMANN:

Dear Sir,—I have examined samples of different kinds of wood, impregnated with rosin under pressure, by your simple and ingenious process, with the following results: By chemical analysis of portions taken from the centre, and from the circumference of each block, it was found on an average that a *cubic foot of freshly cut*

Pine wood had absorbed	3·39	lbs	of rosin.
Chestnut wood "	10·	"	"
" " artificially dried, had absorbed	13·5	"	"
Black Ash had absorbed	4·9	"	"
White Oak "	15·8	"	"
Poplar, or White wood had absorbed	6·2	"	"

While *a cubic foot of old "seasoned"*

Maple wood had absorbed	2·99	"	"
Spruce wood (10 years seasoned), had absorbed	1·75	"	"
Birch wood had absorbed	3·24	"	"

In all the above mentioned cases, the sections were thoroughly impregnated with rosin, and they are sufficient in number and variety to demonstrate that any kind of wood, whether "green" or "seasoned," may be completely saturated with this substance by employing your process.

The advantages attained are that the wood will be permanently preserved from decay, for the following reasons:—

The pores of the wood being filled with rosin, will prevent the entrance of water and matters soluble in it, which ordinarily facilitate the decomposition of organic substances.

The woody fibres being entirely coated with this protecting agent, will not be exposed to the oxidizing influences of atmospheric air.

The nitrogenous principles which so readily ferment, having been subjected to a high temperature during the treatment of the wood, and being resinously enveloped, cannot undergo "*eremacausis or decay.*"*

Resinous bodies were the most prominent ingredients employed by the ancient Egyptians for preserving vegetable, and the much more putrescible animal tissues. You may therefore justly claim not only that in accordance with chemical principles by your process, wood will be shielded from change, but also that mummified cereal grains, as well as animal and human mummies, are practical demonstrations of a similar protection from destroying agencies, for periods extending over 2,000 and even 3,000 years.

An additional and frequent cause of serious injury to woody tissues, is the destruction produced by worms, against which this rosin process is a protection.

Again, a great advantage is that although the pieces of wood are soft and easily worked by ordinary carpenters' tools shortly after saturation, yet in a few days they become indurated and exceedingly hard, which not only renders the resinized fibres more durable, but makes them available for many other purposes beyond those of the same tissues unimpregnated.

The *simplicity* of the apparatus you employ, as well as the *inexpensive* material used, and the slight cost of impregnation, in comparison with the great advantages resulting therefrom, are such as all capitalists will appreciate.

The variety of rosin you require costs at present less than a cent per pound, and but little fuel is necessary for liquifying it, and for generating the pressure necessary for thoroughly introducing it through all the pores of the wood.

The importance of preserving wood from destroying agencies, is too well known to require lengthened demonstration.

* As to the true causes of the decay of wood, I would refer the reader to the article "*Timber Rot,*" in the "*Engineering and Mining Journal,*" of July 27th, 1869.—*A. Ott.*

Dry rot and other influences, so frequently and at times rapidly destructive to wooden ships, to the beams of many of our edifices, to our bridges, railroad ties, etc., etc., which cause annual losses of millions of dollars, and thousands of human lives, are powerful and fearful proofs of the urgent necessity of such potent protecting processes as your valuable invention.

Trusting that you soon may be able to apply it on an extensive scale, I have the honor to remain, Yours respectfully,

R. OGDEN DOREMUS, M. D.,

Prof. Chemistry and Physics, College City of New York. Toxicology, Bellevue Hosp. Md. College.

September 10th, 1868.

Mr. T. W. HEINEMANN:

Dear Sir,—In addition to the statement concerning experiments made with your Rosin Saturated Wood, I should mention that one piece of White Wood, impregnated by your process, and weighing 97·0 grammes, was immersed in water for forty-two days, after which it weighed 98·5 grammes, being a gain of one gramme.

By allowing the water to drain from a few crevices, in the course of half an hour it returned to its original weight.

A piece of the same variety of White Wood, but unsaturated with rosin, and weighing 43·5 grammes, was immersed in water for forty-eight hours, when it had increased in weight to 91 grammes, being more than double its original weight.

These experiments satisfactorily demonstrate that porous woods, capable of becoming thoroughly water-soaked, when impregnated with rosin, after your simple and effective process, can be rendered impervious to water.

I have the honor to remain, Your obedient servant,

R. OGDEN DOREMUS, M. D.,

Prof. Chem. and Toxicol. Bellevue Med. College. Prof. Chem. and Physics, College of the City of N. Y.

SOLAR ECLIPSE OF AUGUST 7, 1869.

(Continued from page 288.)

REPORT OF MR. J. C. BROWNE.

Prof. Henry Morton, Ph. D.

Sir,—Having been requested by you to arrange and make up the chemicals necessary for the use of two of the parties organized in Philadelphia for the purpose of photographing the total eclipse of August 7th, 1869, I made up the following preparations, according to the formulæ given below.

Following the advice given by Mr. Warren De la Rue, in his report on the eclipse of 1860, I used fused nitrate of silver in making up the nitrate bath, in the proportion of 45 grains of silver to the ounce of distilled water, acidulated with 6 drops of nitric acid *CP*. One gallon and a half of filtered silver solution was allowed to each party, carefully packed in two-gallon demijohns in separate boxes. One gallon of distilled water being included in each box, also, extra silver, in case of accident. Five glass dipping baths, holding 20 oz. of solution each, were thought to be sufficient,—each bath enclosed in a wooden box, with a cover to exclude light and dust, and hard rubber dippers coated with paraffine.

Various samples of collodion were made up, but none gave such excellent results as the following mixture:

Alcohol	1 Pint.
Ether	1 Pint.
Cotton	4 grs.

Excited with

Iodide of Am	5 grs.
Bromide of Mag	2½ grs.

Developing solution was made in the proportions of 80 grs. of Proto Sul. of Iron to the ounce of water. No acid was added unless desired for immediate use. The solution was then reduced to the strength of 20 grs. of Iron to the ounce of water, and the addition of 2 drams acetic acid, No. 8, to each ounce.

Cyanide of Potassium was used for fixing, and a liberal allowance of chemicals was included with each out-fit, also, Collodion vials, funnels, filter-paper, brushes, &c.

All the articles were packed in boxes with the name of the respective telescopes marked upon the outside.

I was stationed at Ottumwa, with the section of Prof. Himes, and took charge of the coating of the plates, while Mr. Baker developed them. Our chemicals all worked in the most satisfactory manner.

No re-development was necessary. In most of the exposures the picture came up almost too rapidly, rendering it necessary to have cold water close at hand to check further action. To gain time during the development of so many negatives, after the image was all out upon the plate it was washed slightly and placed in a bucket of water containing a few pinches of chloride of sodium. During the Eclipse, after totality, as many as 8 or 10 plates were placed in the bucket at one time, collodion side towards the inside, afterwards the plates were washed and fixed.

A lot of dilute glycerine had been prepared, but the above plan seemed to answer very well. All the plates were numbered with a diamond and dipped with the number always in the same position.

SOLAR ECLIPSE OF AUGUST 7, 1869.

REPORT OF MR. O. H. WILLARD.

Prof. Henry Morton, Ph. D.

Sir,—Having been requested by you to take charge of the photographic preparation and work for the High School telescope, placed in charge of Prof. A. M. Mayer, at Burlington, Iowa, I made the following arrangements:

The plates and plate-holders being 4½ inches square, I first adjusted the camera so as to secure an image of the sun 2·4 inches in diameter, and then, by repeated trial, found the best actinic focus; adjustment being made by moving the entire eye-piece and camera toward and from the objective, by means of the regular rack and pinion belonging to the telescope. Bringing the eye-piece nearer to the objective shortened the focus of the combination, and was thus equivalent to a withdrawal of the sensitive plate. The distance between the best visual and actinic foci was about $\frac{5}{16}$ of an inch.

I had the requisite chemicals prepared according to the following formulæ.

BATH.

Fused Nitrate of Silver	45 grs.
Distilled water	1 oz.
Nitric Acid	5 drops to the gallon.

Iodized by immersing an 8 by 10 plate flowed with the following collodion:

COLLODION.

Ether	1 oz.
Alcohol	1 oz.
Cotton (Pyroxyline)	10 grs.
Iodide of Ammonium	10 grs.
Bromide of Potassium	4 grs.

DEVELOPER.

Protosulphate of Iron	6 grs.
Water	½ gall.
Acetic Acid No. 8	4 oz.

FIXING SOLUTION.

Hyposulphite of Soda	4 oz.
Water	1 quart.

The exposures during the partial phases were made by the arrangement described in your report, and the smallest slide (*i. e.* that having an opening of $\frac{1}{40}$ of an inch) was used until the last two pictures, which were exposed with $\frac{1}{30}$ inch opening. Only one spring was used throughout.

Six exposures were made during totality, the first two of 5 seconds each, the last four of 8 seconds each. The plates were prepared by Mr. Phillips and developed by Mr. Mahoney with the assistance of Mr. Leisenring, of Galesburgh.

Franklin Institute.

Proceedings of the Stated Monthly Meeting, September 15th, 1869.

THE meeting was called to order with the President, Mr. J. V. Merrick, in the chair.

The minutes of the last meeting were read and approved.

The Actuary submitted the Minutes of the Board of Managers, and reported the donations received since the last meeting of the Institute:—From the Royal Astronomical Society, the Society of Arts, the Chemical Society, the Zoological Society, the Institute of Actuaries, the Statistical Society, the Institution of Civil Engineers, and C. P. Sandberg, Esq., London; the Literary and Philosophical Society, Liverpool, and the Association for the Prevention of Steam Boiler Explosions, Manchester, England; l'Academie des Sciences and la Société d'Encouragement pour l'Industrie Nationelle, Paris, et la Société Industrielle, Mulhouse, France; der Osterreischen Inginieur-veriens, Vienna, and T. C. Winkler, Harlaam, Germany; the Canadian Journal, Toronto, and Major L. A. Huguet-Latour, Montreal, Canada; the Institute of Natural Sciences, Halifax, Nova Scotia; John A. Parker, Esq., Andrew H. Green, Esq., City of New York, the Peabody Institute, Baltimore, Md.; Frederick Emmerick, Esq., the Surgeon General's Office, Washington, D. C.; the American Philosophical Society, Dr. W. S. W. Ruschenberger, R. A. Parrish, Jr., Esq., and Prof. John C. Cresson, Philadelphia.

The various Standing Committees reported their minutes.

The Resident Secretary read his report on Novelties in Science and the Mechanic Arts, after which the meeting, on motion, adjourned.

HENRY MORTON, *Secretary.*

On account of its special interest at the present time we here publish the paper read at the succeeding meeting, whose minutes will in regular course appear next month after they have been duly read and approved.—ED.

THE EJECTOR CONDENSER FOR STEAM ENGINES.

(Paper read before the Franklin Institute at its Regular Meeting, Oct. 20, 1869.)

BY JAMES R. NAPIER, F. R. S., &c.

IT is well known that the ordinary jet condenser requires a pump to remove the air, and the water used in condensation. Mr. Alex. Morton, of Glasgow, while experimenting on a Giffard's Injector, discovered that the pump could be dispensed with, that the exhaust

steam itself could do that work, that the steam after forcing its piston to the end of the cylinder had sufficient energy left to take itself, and any air with which it might be combined, out of the cylinder and produce a vacuum equal to that by the best condenser and air-pump of the ordinary construction.

The apparatus which he invented to enable the steam to do this work, and which he calls an Ejector Condenser, is shown in the plates. It is very similar in arrangement and mode of action to a Giffard's Injector. The cold water wanted for condensing the steam, if below the apparatus, is raised by a jet of steam (*a*) in the same manner as in Giffard's or Sellers' Injectors. When the vacuum is formed in the cylinders of the engine this steam jet is stopped by means of the double piston valve arrangement (*b*), and it may be prevented from stopping or be partially stopped by the screw nut (*o*) on the rod of the double piston.

The exhaust steam from one cylinder enters the apparatus at (*c*), and from the other cylinder, if there are two, at (*d*). The condensation takes place at the nozzles (*e*) and (*f*), respectively. The condensed steam, water and air are discharged by the trumpet-shaped tube (*g*) into the chamber or hot well (*h*), surrounding that tube. From the hot well the feed water for the boiler is drawn by any of the ordinary appliances. The rest of the products of condensation is discharged at (*e*). A valve (*m*) at the wide end of the discharge pipe prevents the water in the hot well from being drawn into the cylinders when the engine stops.

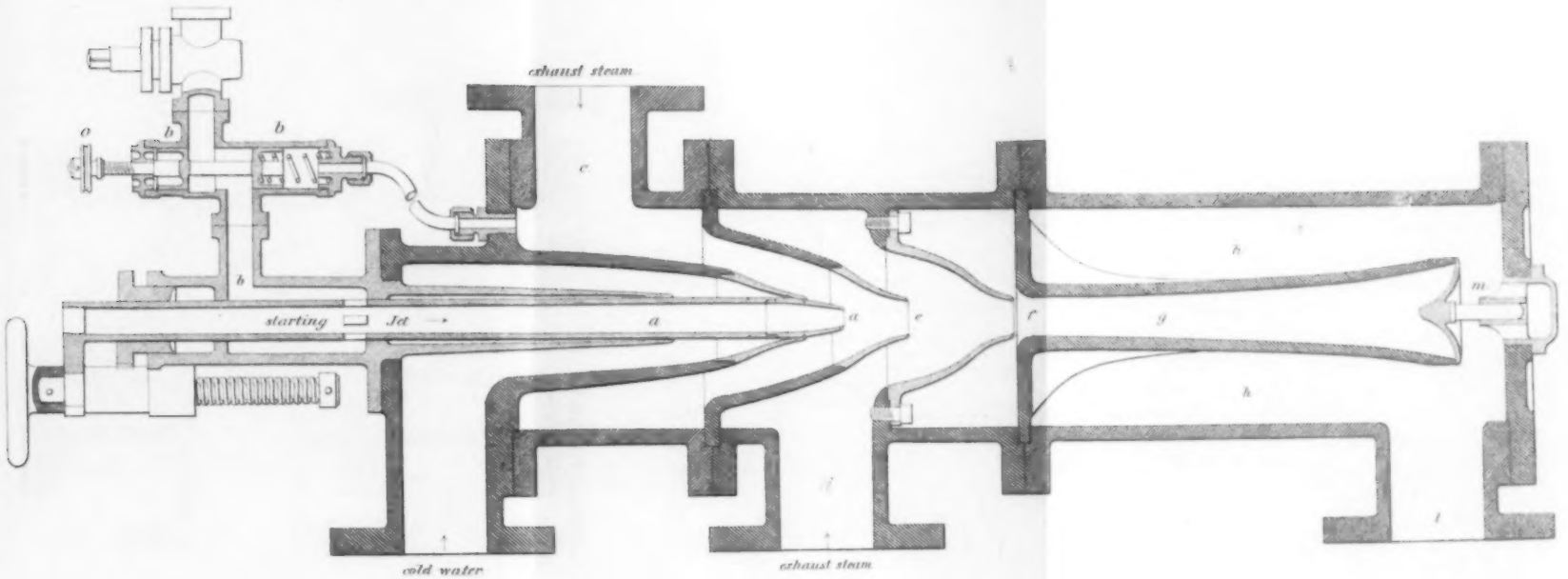
Experiments have been made by Professor Rankine, of the University of Glasgow, one of the ablest men for such a purpose, with an Ejector Condenser, on a small double cylinder engine, of about 18-inch stroke, and 10¼-inch diameter, made for showing its powers. The results he communicated, in November, 1868, to the Institution of Engineers in Scotland, and very recently, September, 1869, he experimented on an ejector applied to a larger engine pumping water from a coal mine at Dalry, near Glasgow.

[A copy of this report, the speaker intended to have presented to the meeting, but he had not received it when expected.]

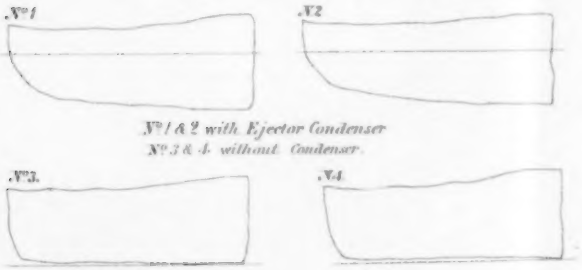
These Ejectors can easily be worked into the design of any new engines intended for condensation, and also with little trouble, added to many existing non-condensing engines where it would be impracticable or too costly now to apply the ordinary jet condenser and air-pump. The saving of fuel, increase of power, decrease of pressure on boiler, or increase of speed of steam vessels, will, no doubt, in such cases, be the same for the same pressure in the condenser by whatever system the condensation is procured. Prof. Rankine has shown, however, that in the engine he experimented upon, in November, 1868, all the power required to work the air-pump was saved.

And although the speaker was not aware of the reasons which have induced American engineers to use so commonly non-conden-

THE EJECTOR CONDENSER
FOR TWO COUPLID CYLINDER ENGINES

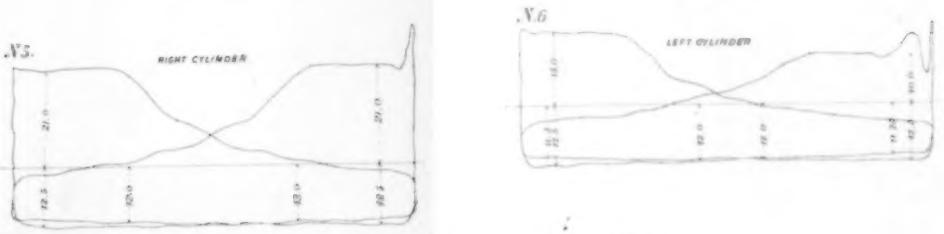


Cards from Ryesholm pumping Engine 11 Sept. 1869.



N°1 & 2 with Ejector Condenser
N°3 & 4 without Condenser.

Cards from double Cylinder Engines with Mortons Ejector Condenser Nov. 1868



Mortons Patents
3 West Nile Street Glasgow

Lith by Jas. Mc Guigan Phil.a

sing engines for many of their river boats, he thought that the Ejector Condenser removed the objections of complication, weight, space and deterioration from muddy water, commonly urged in Britain against condensing engines, and if the first cost was the chief objection to condensing engines, Morton's Ejector would evidently cost the manufacturer much less than the common jet condenser and air-pump. But at what rates they would be sold here depended on how the American patent was to be worked.

The selling price in Glasgow, however, of one of these Ejectors for a 10 or a 12-inch cylinder, and having probably a ¾-inch water jet, was about £30 or about $190 currency.

The theory of the working of Giffard's Injector, as manufactured by Messrs. Wm. Sellers & Co., of Philadelphia, has been so simply explained by Prof. Henry Morton, in the *Journal of the Franklin Institute*, that the speaker had no doubt the same gentleman would be able to satisfy the members of the soundness of the principles on which Morton's Ejector Condenser is based.

It worked well in Great Britain on fast and on slow going engines. on engines with one and on engines with two cylinders. The indicator cards, Plate showing the vacuum obtained during Prof. Rankine's experiments speak for themselves.

Messrs. Dennistoun & Co., of New York, who have the disposal of the American patent have authorized the erection of one of these condensers in that city, and it is expected to be at work in a few weeks.

Observations were made by various gentlemen as follows:

Mr. Robert Briggs said that the invention was undoubtedly an important step in the improvement of the parts of the steam engine, rivaling in its value the apparatus it was based upon, the Injector of Giffard. It should be considered as a further development of the discovery of Mr. Giffard. About nine years since he had the pleasure of assisting in some experiments, instituted by Mr. William Sellers, for the purpose of determining the quantities of water which would be delivered by Giffard Injectors of different sizes, under different pressures and with varying temperatures and lifts of supply water. Very numerous experiments with many sizes of Injectors were made at that time, and when the conditions of temperature and lift of supply water were constant, in place of giving a variation of delivery proportional to the square root of the absolute pressure of steam, or of that of the pressure of the steam above the atmosphere, it had been found that the delivery varied with the square root of the pressure of the atmosphere plus 8 pounds, ($v \propto \sqrt{P+8}$). This he considered as indicating a partial vacuum of 6·7 pounds tension in the condensing nozzle, and appeared to demonstrate the possibility that with some form of instrument proportioned especially for this end, both that a more complete vacuum would be attainable and that a pressure of steam below the atmosphere might

be made to feed a boiler at working pressure. In other words, the boiler could possibly be fed by the use of the exhaust steam of an engine which it supplied in an Injector. And this function of a partial vacuum demonstrated positively that within the instrument the steam acted independently to the atmospheric pressure, so that this new application is consistent with the results attained by those experiments.

Mr. Wm. Sellers remarked that he had no doubt if the nozzles of the Ejector were properly formed, it would lift water from any depth within the limits of an ordinary suction, or, in other words, atmospheric pressure. His own arrangement of the Giffard Injector, by proportioning the inflow of steam to the capacity of the discharging tubes, accomplished this result.

With regard to slow working engines, he thought there would be no difficulty in keeping up the water jet during the cessation of the steam discharge, providing the water supply or delivery pipe or both were of sufficient length. In his opinion it would be found especially important in this class of engines that the *delivery* pipe should be long, as in that case we should have a large mass of water in motion which would not be checked by a temporary suspension of the impelling force, thus maintaining the vacuum and retaining the water supply in position to condense the successive discharges from the exhaust without having any recourse to the live steam and regulating valve.

Mr. Thomas Shaw described a plan for ejecting steam, air and water, having some relation to the ejector patented by himself.

In reply to various questions by Messrs. Sellers, Briggs, Shaw, Prof. Rogers and others, Mr. Napier stated that the greatest length of stroke to which he had seen the Ejector applied was the Dalry Engine, reported upon by Prof. Rankine, in September, 1869; it had a 4½ feet stroke, making 20 to 24 revolutions per minute, and a vacuum in the exhaust pipe of about 23½ inches of mercury.

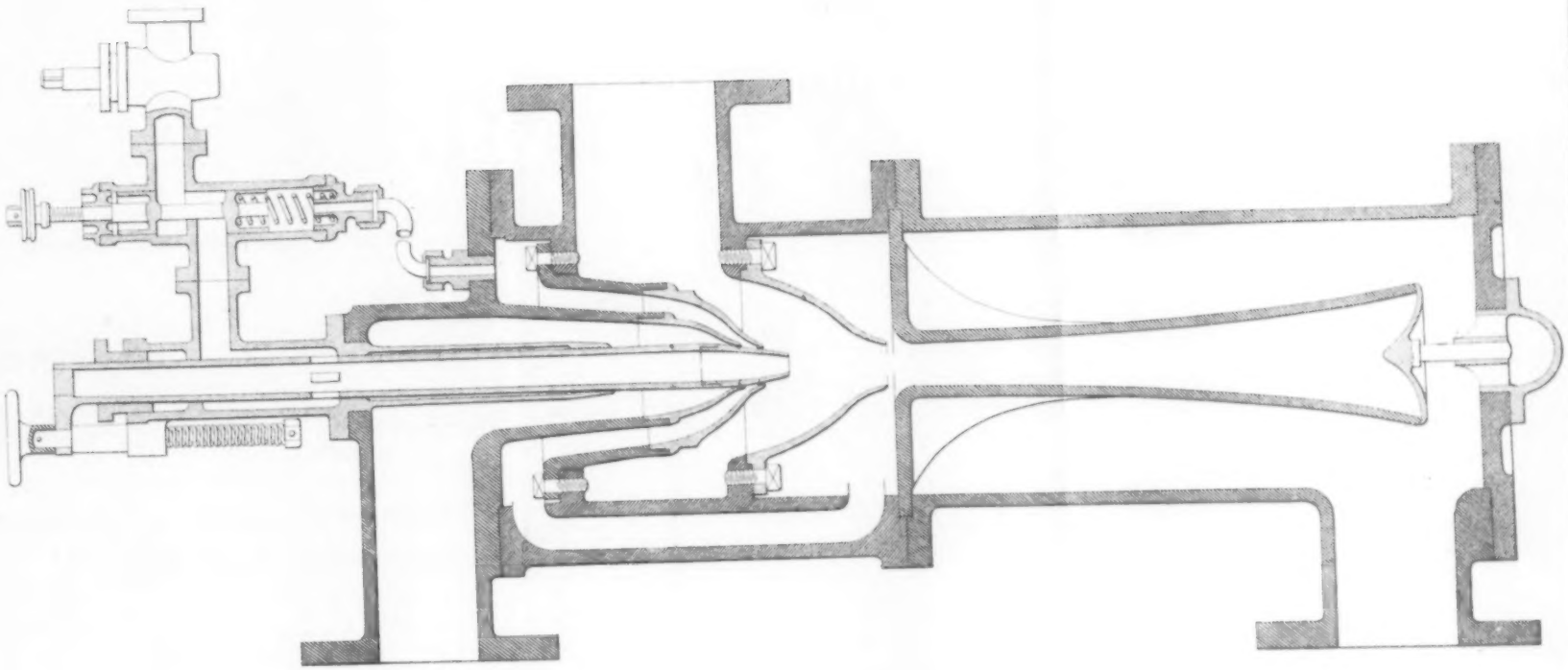
He had seen the first of Morton's Ejector Condenser at the Lugar Iron Works in Ayrshire, it had then been at work about 18 months, and was producing a vacuum of from 8 to 10 pounds. He had not seen the Ejector on any slow-working engines, but Mr. Morton had stated that one was at work on an engine making six revolutions per minute.

That an Ejector was now being made for a pumping engine having a 48-inch cylinder and 9 feet stroke, making 10 strokes per minute. In this case no steam jet is intended to be used, as the cold water comes from a height of about 10 feet to the Ejector. It had not yet been applied to sea-going steamers as a substitute for surface condensers, although it might probably be made applicable by cooling the water of condensation.

Mr. Morton found that the Ejector on single cylinder engines worked best with from 10 to 20 feet of suction pipe, the contained mass of water keeping a steadier vacuum.

THE EJECTOR CONDENSER

FOR SINGLE CYLINDER ENGINE



Martons Patents.
32 West Nile Street Glasgow

Lith. by Jas. M'Gaugan.